Conservation of Herps

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- Why, and what, should we conserve?
- How do humans affect wild species?
- What can we do?

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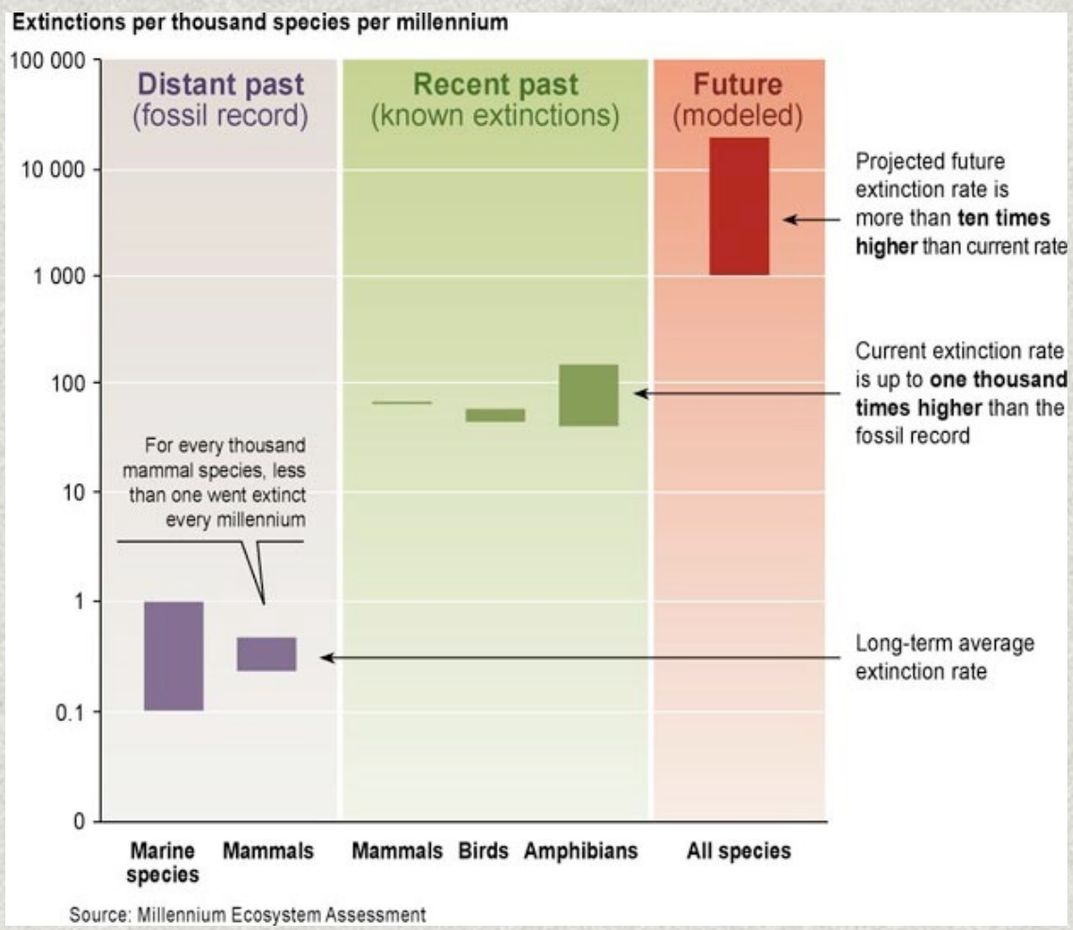
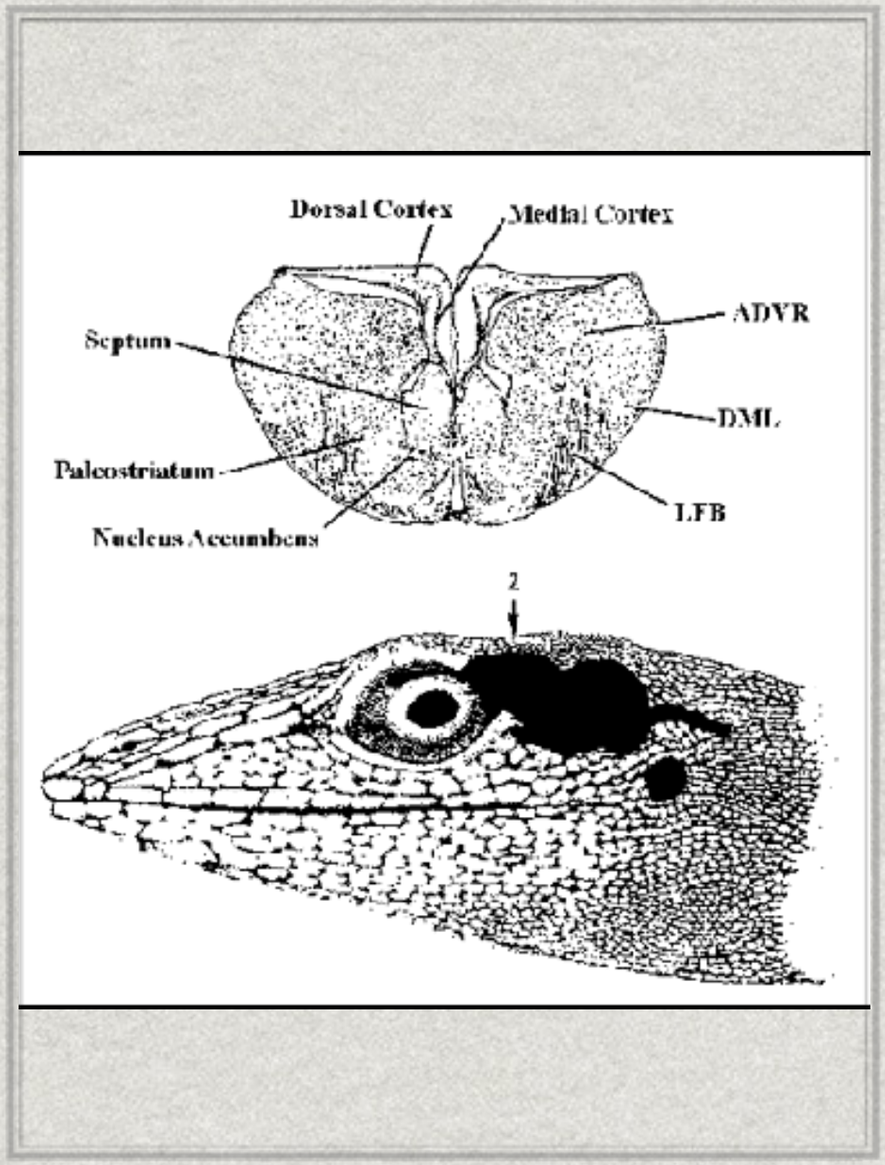
Importance of Conservation



- Humans are having an increasingly strong impact on the environment
- This has led to elevated extinction
- But, why should we care?
- For example: why conserve the tailed frog?

Direct Benefits to Humans

- Some herps directly benefit humans
- For example, anoles are used for brain research
- Two halves of the brain are not connected



Indirect Benefits to Humans

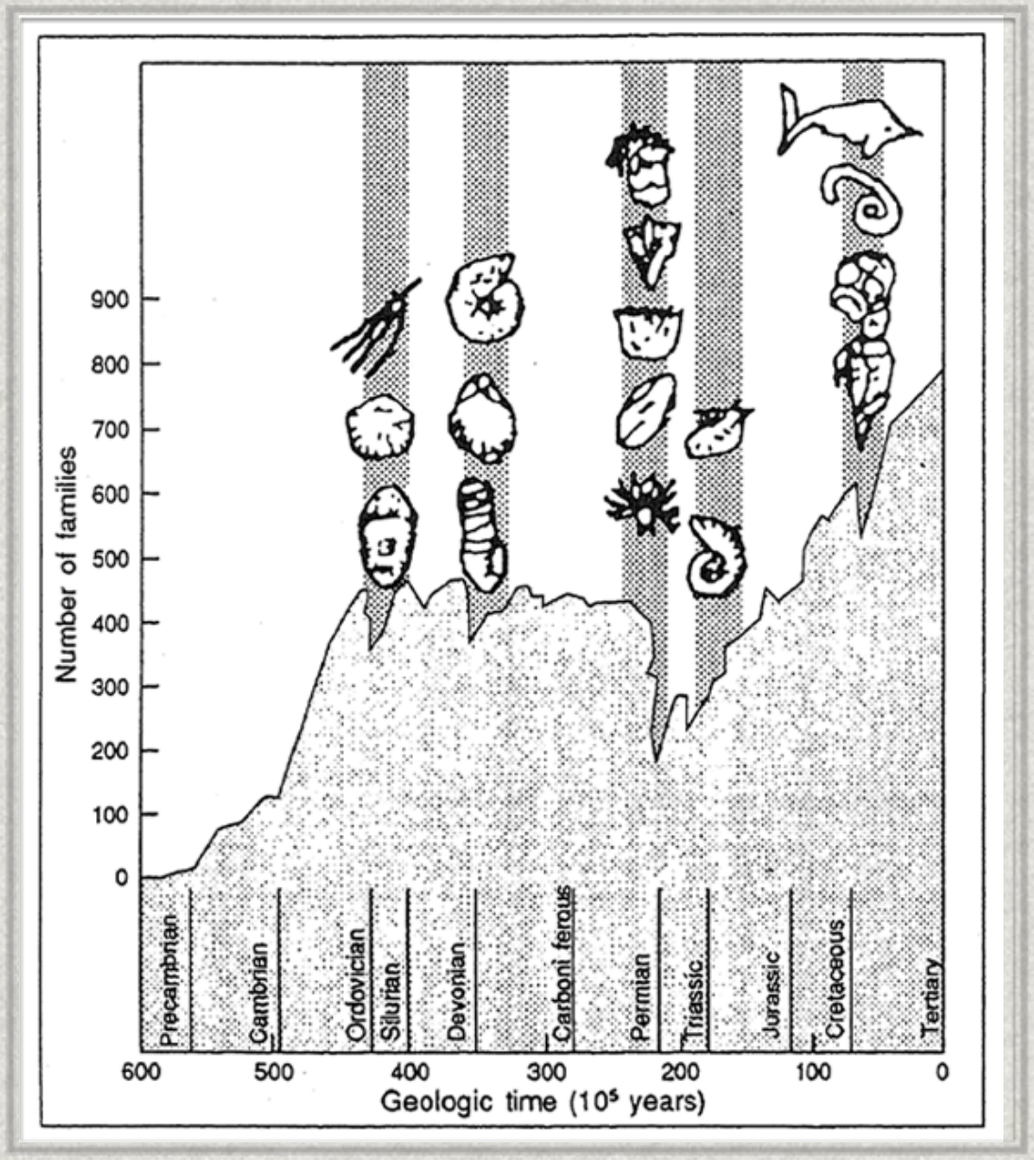
- Herps form key components of many communities
- Intact ecosystems provide key “ecosystem services” for humans

Ethical Reasons

- “We do not inherit the earth from our ancestors, we borrow it from our children”

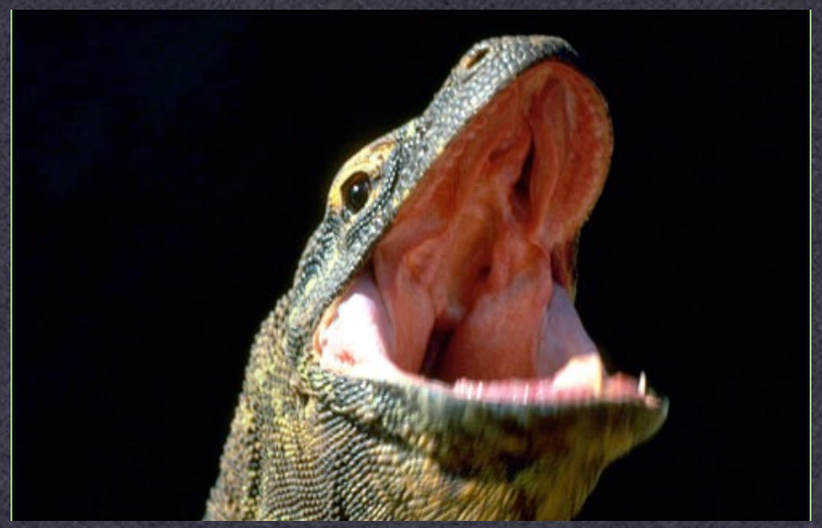
Won’t the Earth recover?

- Extinction is a natural process, and has been happening for millions of years
- The earth will recover from this mass extinction
- It’s likely to take at least 50 my
- This time scale is basically irrelevant to humans



What should we conserve?

- The idea that we should conserve the natural world is becoming more and more prevalent
- If we decide to conserve, where should we focus our efforts?
- There is a limited amount of time and resources available.

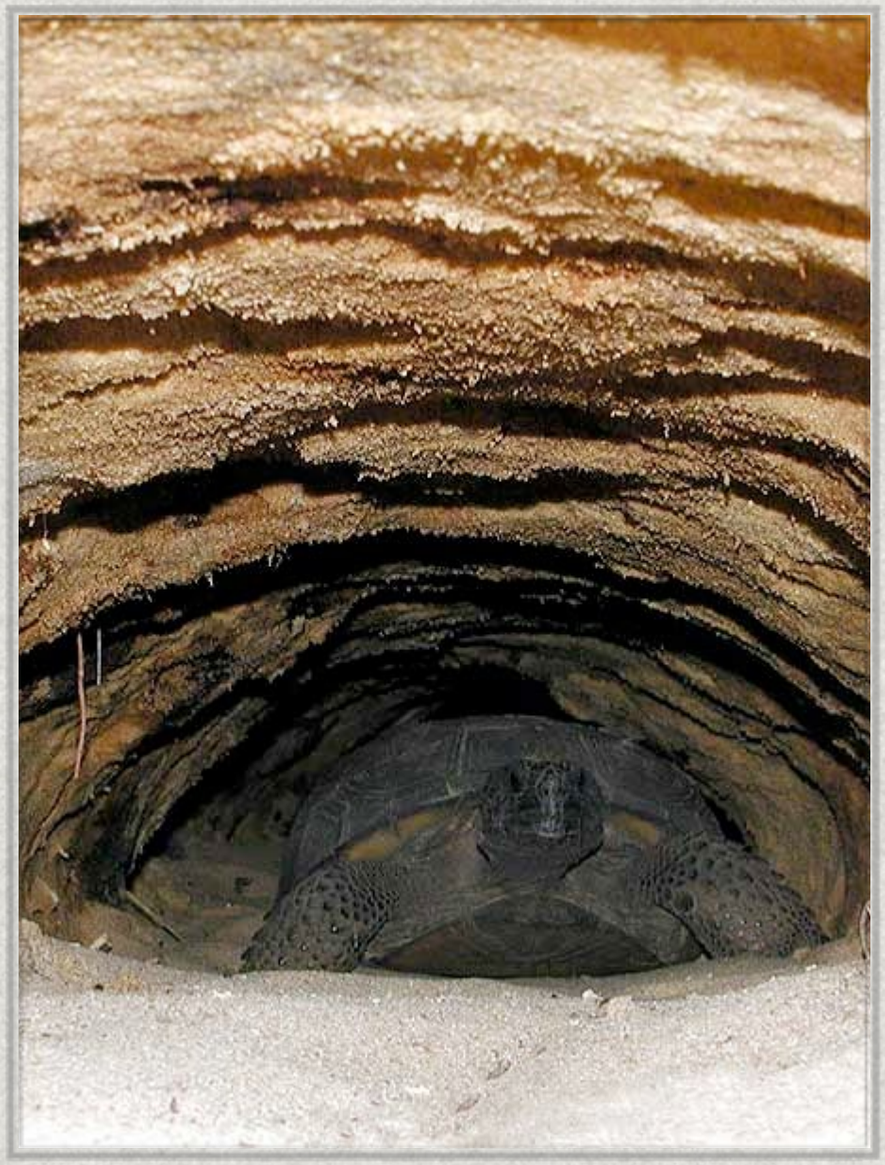


CHARISMATIC SPECIES

SPECIES THAT ARE LARGE, BRIGHTLY COLORED, OR OTHERWISE “AWESOME”

Keystone Species

- Species that play a key role in a community or ecosystem
- Example: gopher tortoise (*Gopherus polyphemus*)
- Excavate burrows that are used by a wide range of other species

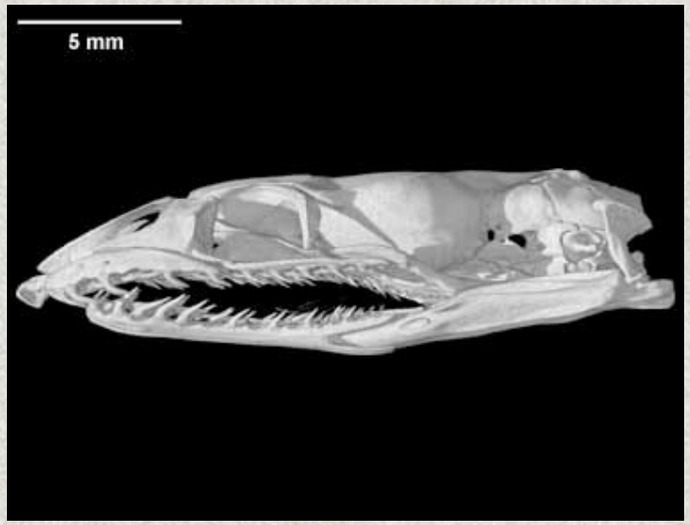


Species at Risk

- Try to target species that are especially threatened
- Rare, in threatened habitats, affected by humans, etc.
- Example: IUCN Red List

Herps at Risk

- Long-lived
- Low reproductive rates
- Large
- Poor dispersal or colonization abilities
- Small range size
- Colonial nesting
- Migratory



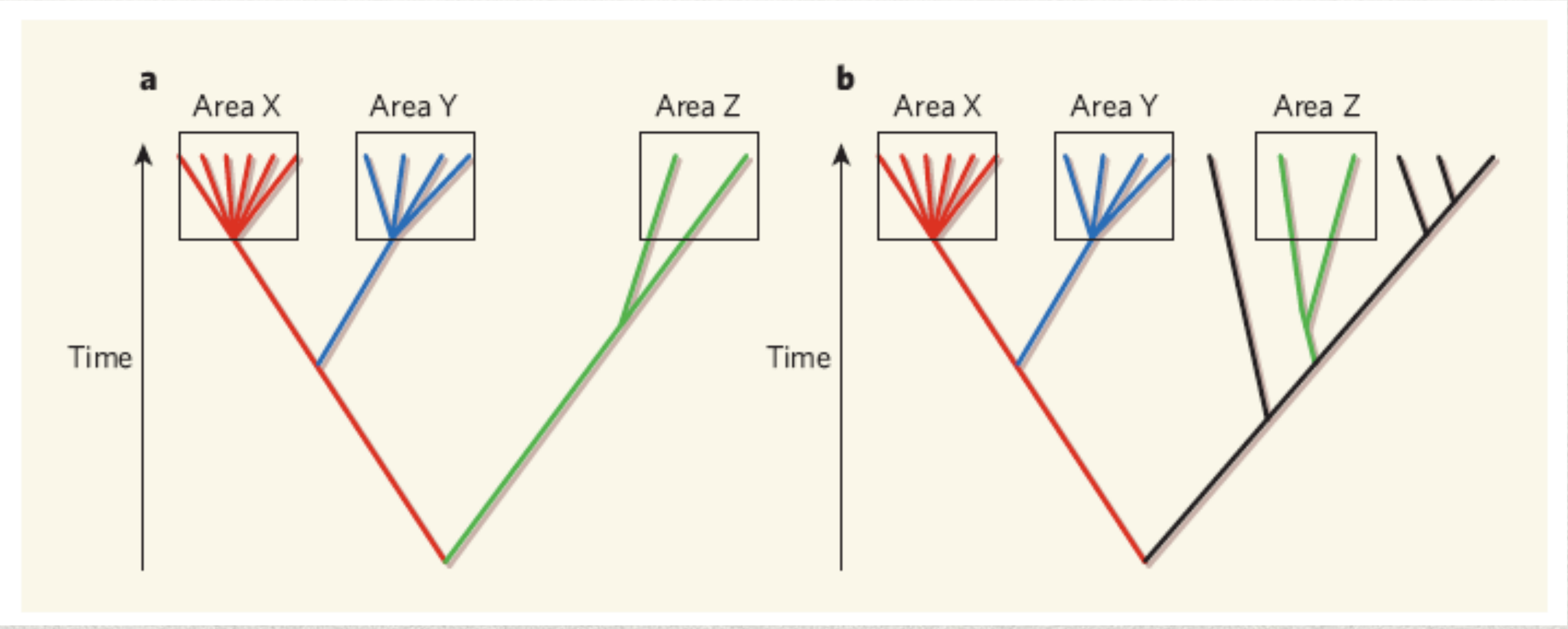
ROUND ISLAND BOA

CASAREA DUSSUMIERI

Phylogenetic Heritage

- Try to conserve evolutionary heritage
- Save the longest branches on the phylogenetic tree
- Examples:
  - don’t lose all the species in a genus
  - save the tuatara

Phylogenetic Heritage



FROM MOOERS 2007

Whole Ecosystems

BLACK RIVER GORGES NP
MAURITIUS

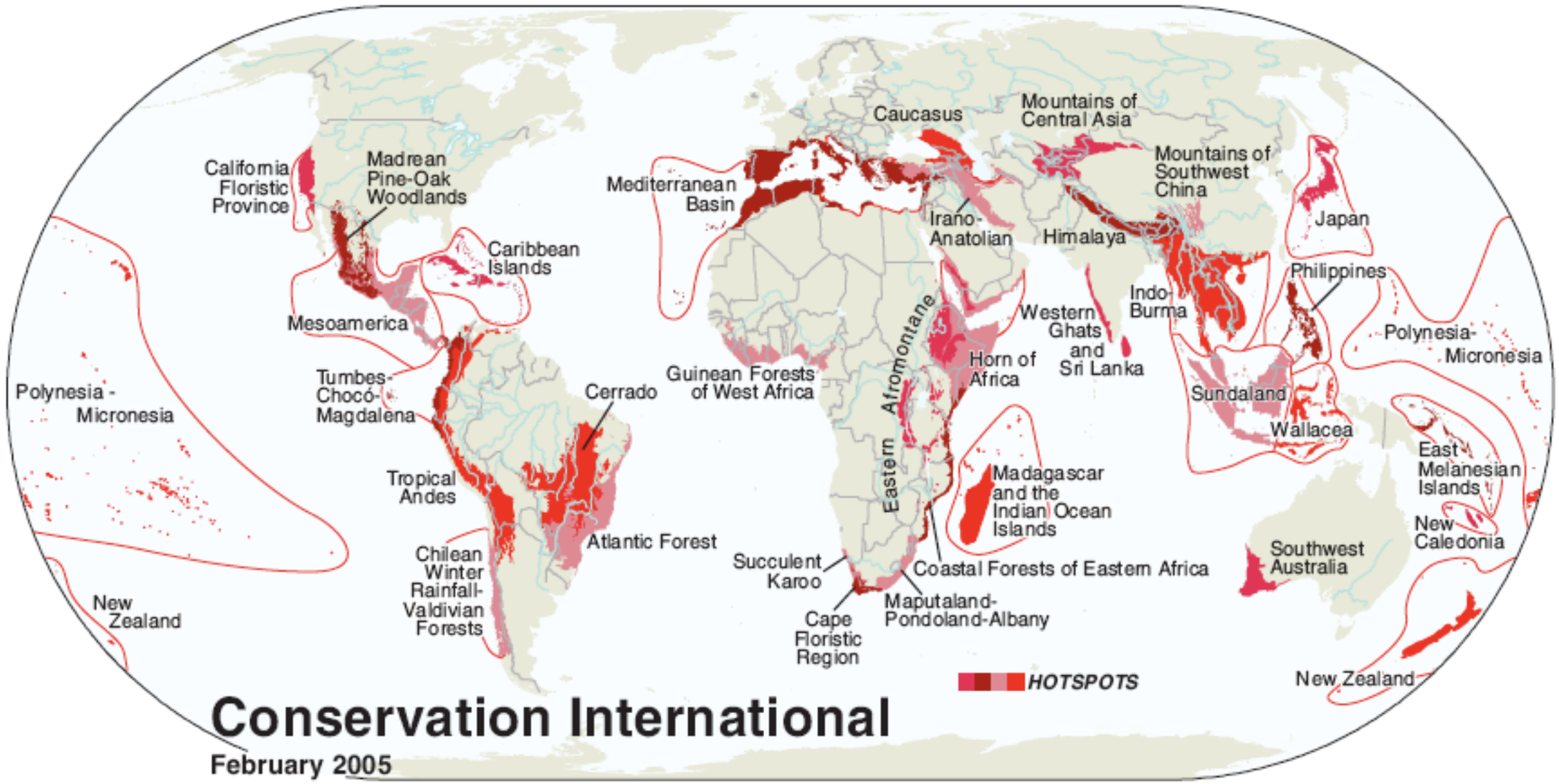
- Instead of saving individual species, we should target sets of interacting species
- Impossible to save the parts without the whole

Biodiversity Hotspots

- Ecosystem conservation is expensive
- Target areas that have exceptional biodiversity and high habitat loss

TEXT

HTTP://WWW.BIODIVERSITYHOTSPOTS.ORG/


California Floristic Province
Madrean Pine-Oak Woodlands
Caribbean Islands
Mesoamerica
Tumbes-Chocó-Magdalena
Polynesia - Micronesia
Tropical Andes
Cerrado
Atlantic Forest
Chilean Winter Rainfall-Valdivian Forests
New Zealand
Mediterranean Basin
Caucasus
Mountains of Central Asia
Irano-Anatolian
Himalaya
Mountains of Southwest China
Japan
Philippines
Indo-Burma
Western Ghats and Sri Lanka
Horn of Africa
Guinean Forests of West Africa
Afromontane
Eastern
Madagascar and the Indian Ocean Islands
Coastal Forests of Eastern Africa
Succulent Karoo
Cape Floristic Region
Maputaland-Pondoland-Albany
Sundaland
Wallacea
Polynesia-Micronesia
East Melanesian Islands
New Caledonia
Southwest Australia
New Zealand
HOTSPOTS
Conservation International
February 2005

Levels of Biodiversity

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- So far, we've focused mainly on species diversity

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- There are other important aspects of biodiversity of concern

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Levels of Biodiversity

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- There are other important aspects of biodiversity of concern
- Genetic diversity
- Species diversity at other levels (alpha, beta, and gamma)
- Community / ecosystem diversity

Genetic Diversity

- Genetic diversity is essential for natural populations
- Short term: avoid inbreeding depression
- Long term: adapt to changing environments

Conservation of Herps

- Why, and what, should we conserve?
- How do humans affect wild species?
- What can we do?

Human Effects on Wild Species

- Habitat destruction
- Introduced species
- Pollution
- Direct exploitation

Habitat Destruction

- The number one threat facing species today is habitat destruction
- Habitats are being converted by humans into monocultures
- Few species can survive in these altered habitats

LOWLAND FORESTS IN MAURITIUS

ALMOST ALL HABITAT CONVERTED TO SUGAR CANE

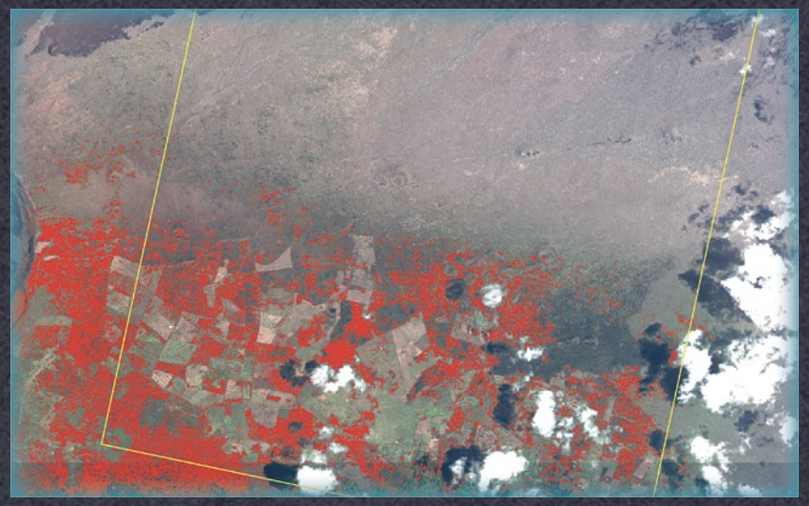
HISPANIOLA

BORDER BETWEEN HAITI AND THE DOMINICAN REPUBLIC

Introduced species

- A major problem worldwide
- Invasive species affect native herps
- Invasive herps affect native species

MAURITIUS



INVASIVE GUAVA IN GALAPAGOS

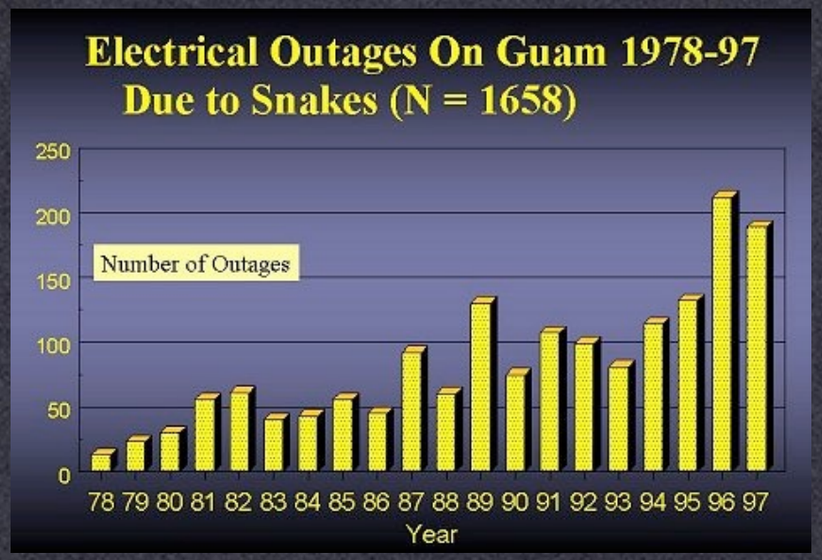
INVASIVE SPECIES AFFECT NATIVE HERPS

VERY COMMON PROBLEM ON ISLANDS

MICONIA, THE “GREEN CANCER”

HUGE PROBLEM IN TAHITI; SPREADING IN HAWAII

Results of one night's captures by hand.



THE BROWN TREE SNAKE

BOIGA IRREGULARIS

WHITE-THROATED GROUND DOVE
(GUAM SUBSPECIES)
1986

RUFOUS FANTAIL
(GUAM SUBSPECIES)
1984

MARIANA FRUIT DOVE
1985

NIGHTENGALE REED-WARBLER
(GUAM SUBSPECIES)
1970

CARDINAL HONEYEATER
(GUAM SUBSPECIES)
1984

GUAM FLYCATCHER
1984

EXTINCTIONS CAUSED BY THE BROWN TREE SNAKE

INTRODUCED IN ~1950

Pollution

- Pollution from humans has a direct effect on herps
- Amphibians particularly affected due to their permeable skin
- Pollutants interact with other factors and lead to amphibian declines

DEFORMED WOOD FROGS
RANA SYLVATICA
FROM POLLUTION AND TREMATODE PARASITE

Chemical contamination

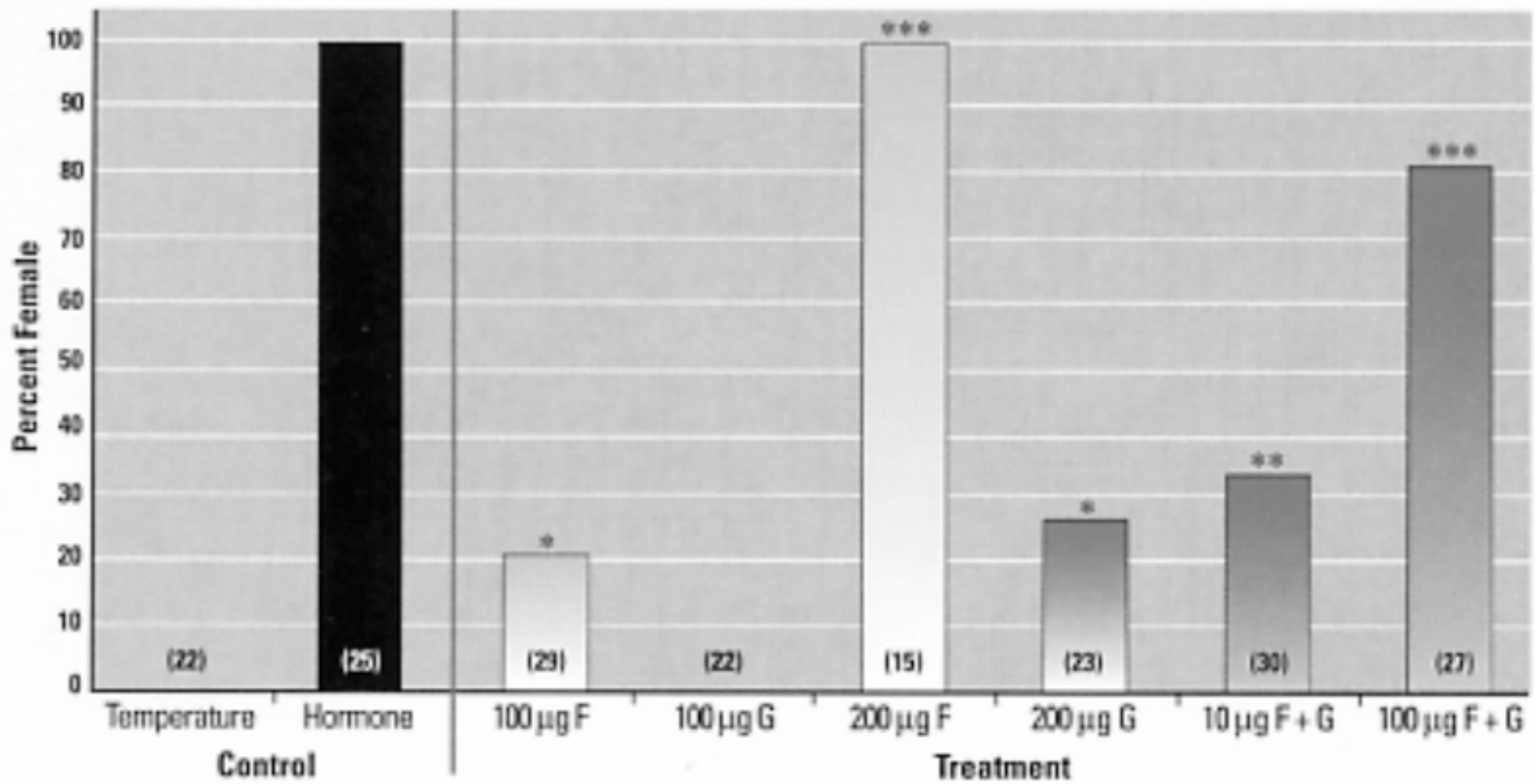


Figure 1. Percentage of female hatchlings at a temperature that normally produces 100% males (26°C) after treatment with two estrogenic PCB compounds in ethanol. Controls: temperature, ethanol alone; hormone, 10 µg estradiol-17ß. PCB compounds: F, 2′,4′,6′-trichloro-4-biphenylol; G, 2′,3′,4′,5′-tetrachloro-4-biphenylol. Sample sizes in parentheses. Significant sex reversal is indicated by $^{*}p \leq 0.03$; $^{**}p = 0.003$; $^{***}p = 0.0001$.

EFFECTS OF PCB ON SEX DETERMINATION IN RED-EARED SLIDERS

BERGERON ET AL. 1994

Direct exploitation

- Herps are used by humans
- Food and medicine
- Products
- Pet trade

HERPS AS FOOD AND MEDICINE

"BUSHMEAT" IS A CONCERN IN SOME PLACES

CORUCIA ZEBRATA

PREHENSILE-TAILED SKINK, SOLOMON ISLANDS

WILD-CAUGHT HERPS FOR THE PET TRADE

NEAR ANDASIBE, MADAGASCAR

Conservation of Herps

- Why, and what, should we conserve?
- How do humans affect wild species?
- What can we do?

Three Keys for Successful Conservation

- Local people must be on-board
- Habitat destruction is the main problem
- We don’t know enough about species in natural populations

Local people

Local people

- People living near areas of conservation concern must be involved in conservation activities

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- These are the people who are affected most by conservation programs, and in turn have the most effect on natural habitats

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- These are the people who are affected most by conservation programs, and in turn have the most effect on natural habitats
- Buying land and kicking people off is often not a good long-term strategy
- Local people should gain some benefits from conservation

Habitat Destruction

- Minimizing habitat destruction is the most effective method for conservation
- Also mitigate effects of habitat destruction
- Example: create corridors for migration between habitat fragments

PROPOSED WILDLIFE CORRIDOR

Research

Research

- What types of research are most valuable?

Research

- What types of research are most valuable?
  - What is out there?

Research

- What types of research are most valuable?
  - What is out there?
  - What are the specific effects of certain policies?

Research

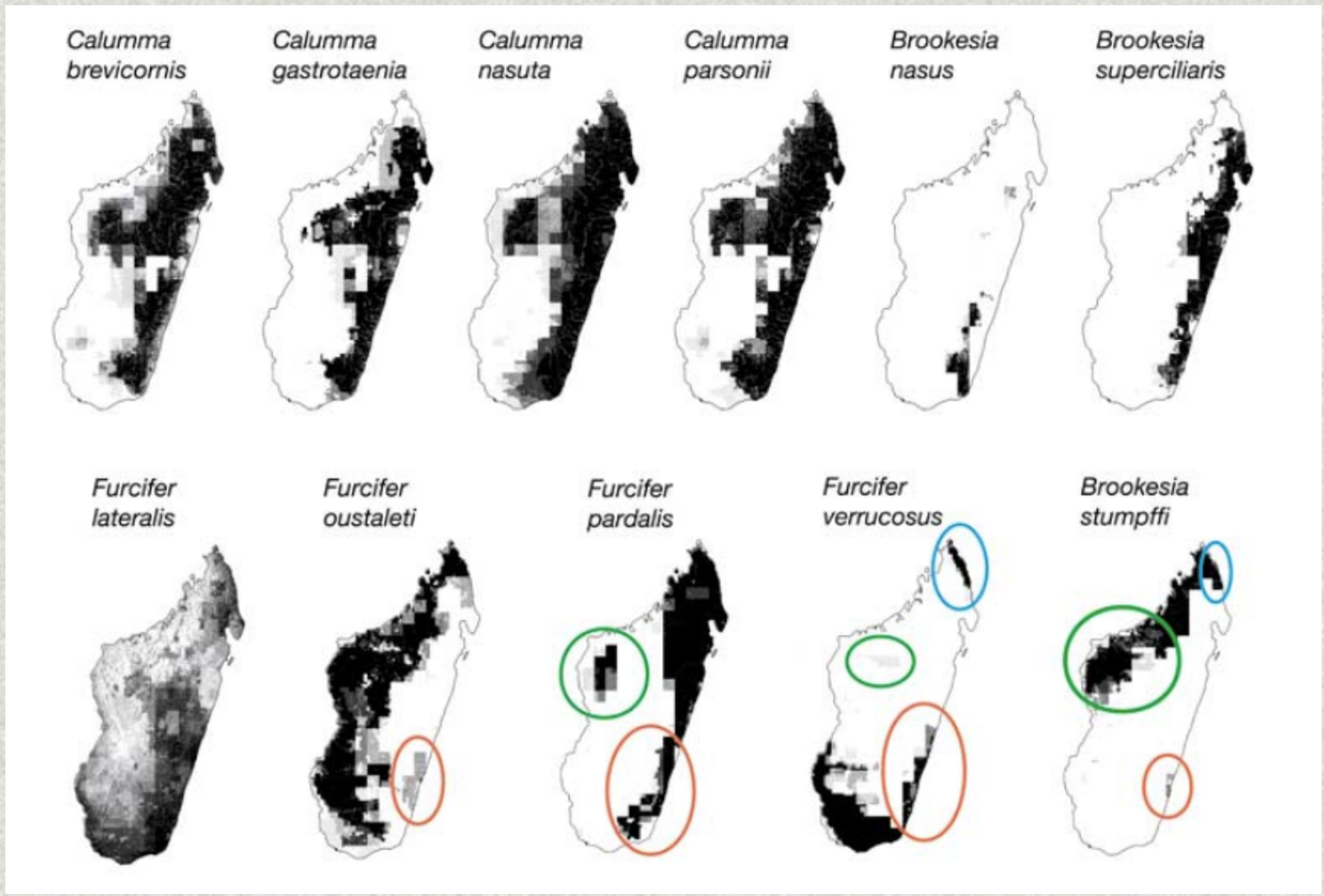
- What types of research are most valuable?
  - What is out there?
  - What are the specific effects of certain policies?
  - How do species interact?

What is out there?

- Genetic surveys
- Biodiversity inventories
- Community-level analyses

Example: Malagasy Herps

- Modeled habitat requirements for known species of chameleons
- Traveled to unexplored areas predicted to be suitable
- Identified 7 new species in those areas



RAXWORTHY ET AL. 2003

Conservation of Herps

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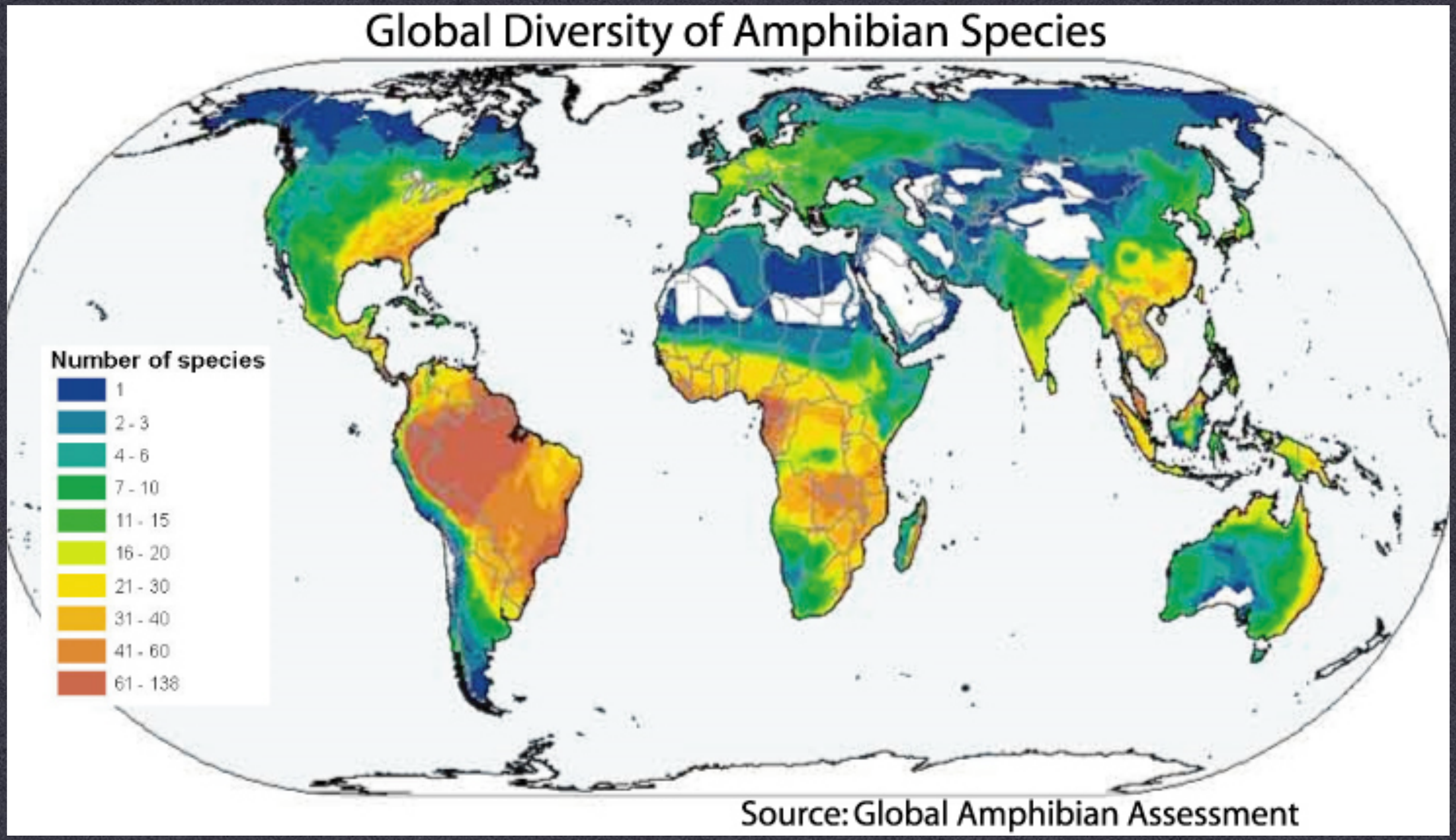

CASE STUDY: AMPHIBIAN DECLINES

A CURRENT CRISIS IN CONSERVATION

Amphibian declines

- Identify and describe the problem
- Test possible causes
- Investigate potential solutions

Amphibian declines

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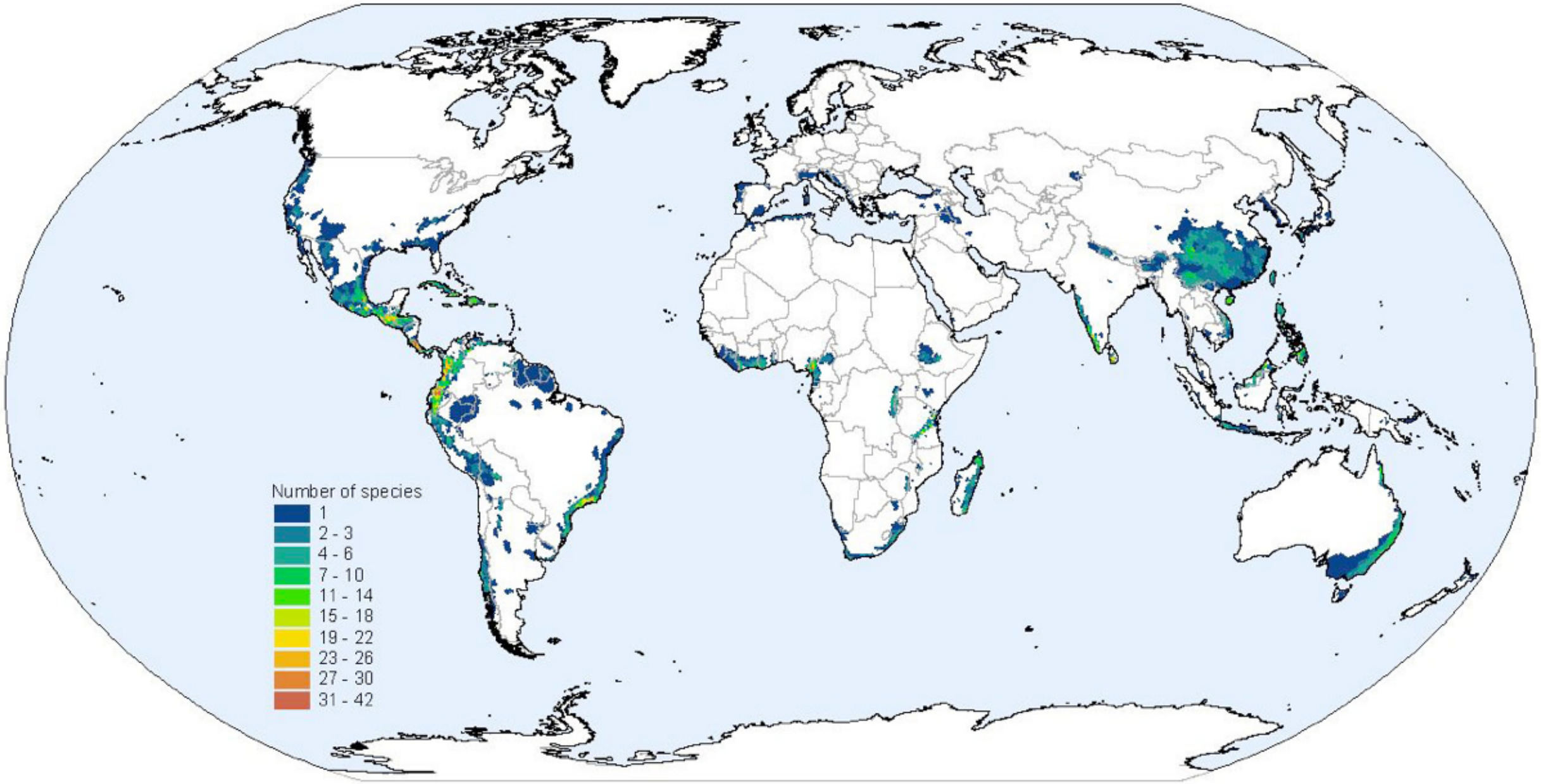
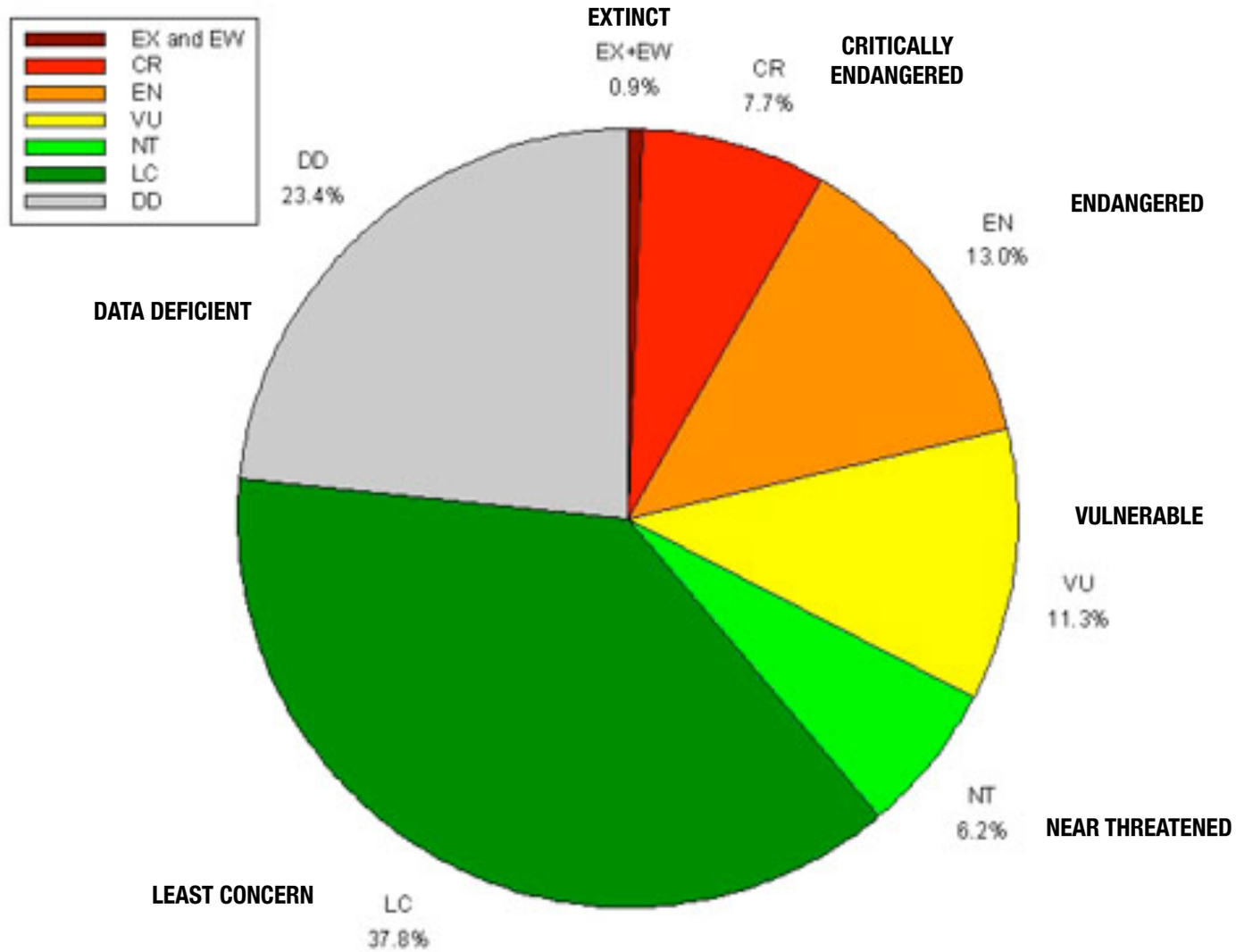


32% OF THE WORLD'S AMPHIBIANS ARE THREATENED

1856 OUT OF ~6000 SPECIES

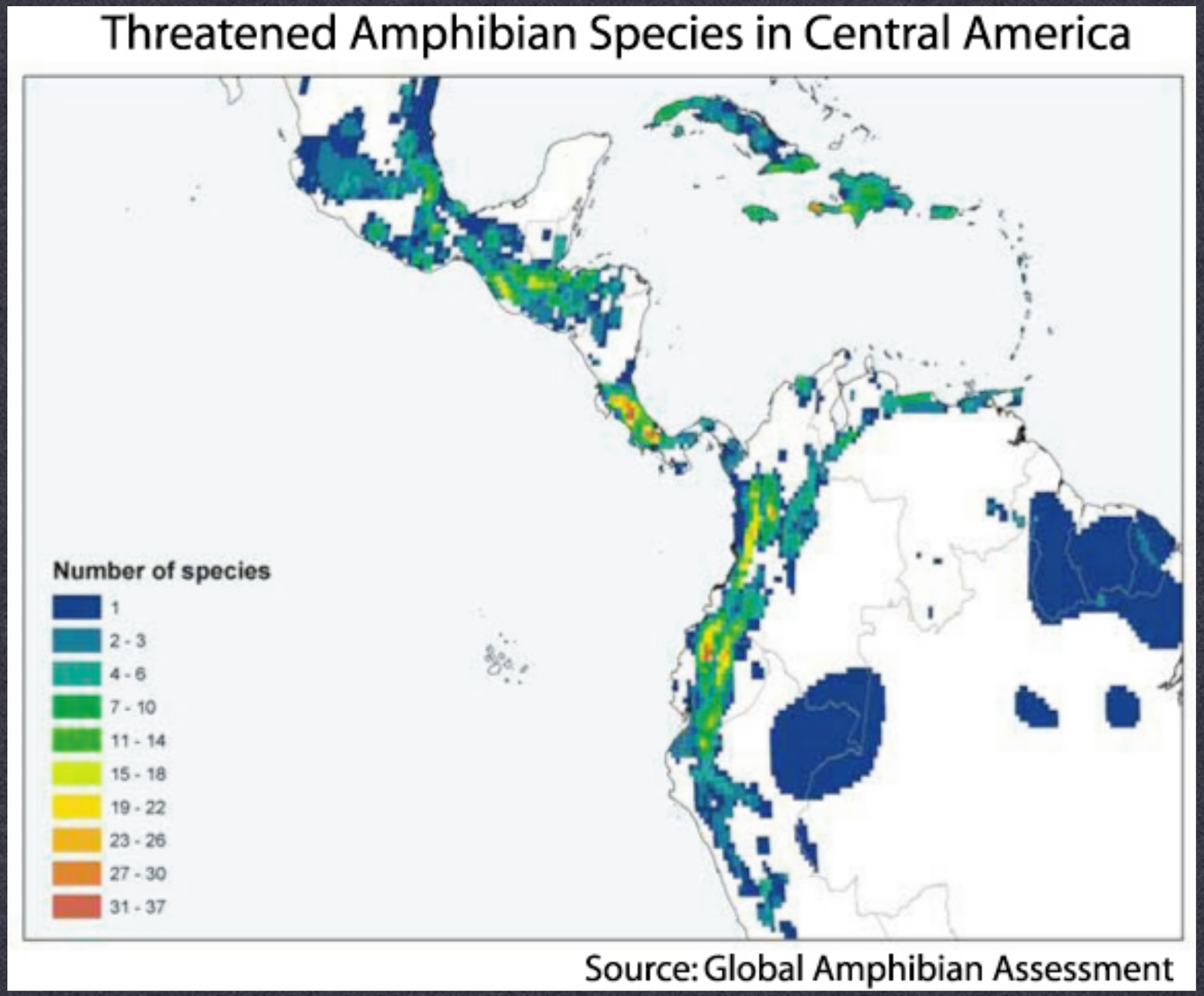
RED LIST STATUS OF AMPHIBIANS



~160 SPECIES ALREADY EXTINCT

(THAT WE KNOW ABOUT)

BOTH EXTINCT IN THE 1980S



PROBLEM AREA: CENTRAL AMERICA

Amphibian declines

- Identify and describe the problem
- Test possible causes
- Investigate potential solutions

Possible Causes

- Habitat destruction
- Introduced species
- Over-exploitation
- Climate change
- UV-B Radiation
- Chemical contaminants
- Disease
- Deformities
- Synergies

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ENCROACHING URBANIZATION IN HABITATS OF THE RED-LEGGED FROG IN CALIFORNIA

CLEARCUT IN COASTAL FORESTS OF OREGON

EFFECTS OF CATTLE ON PONDS (NOTE FENCED-OFF SIDE)

HABITAT DESTRUCTION, ALTERATION, FRAGMENTATION

A MAIN THREAT TO AMPHIBIANS

Depressing Statistics

- 70-90% loss of wetlands in Connecticut, Maryland and Ohio between 1780 and 1980
- 50% loss of everglades ecosystem by the early 1990s; the remainder greatly altered
- 98% of the original 5.2 million kilometers of streams in the continental United States have been seriously affected
- 0.01% of native grasslands remain in pre-European contact condition

Possible Causes

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- Introduced species
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Introduced Fish and Frogs

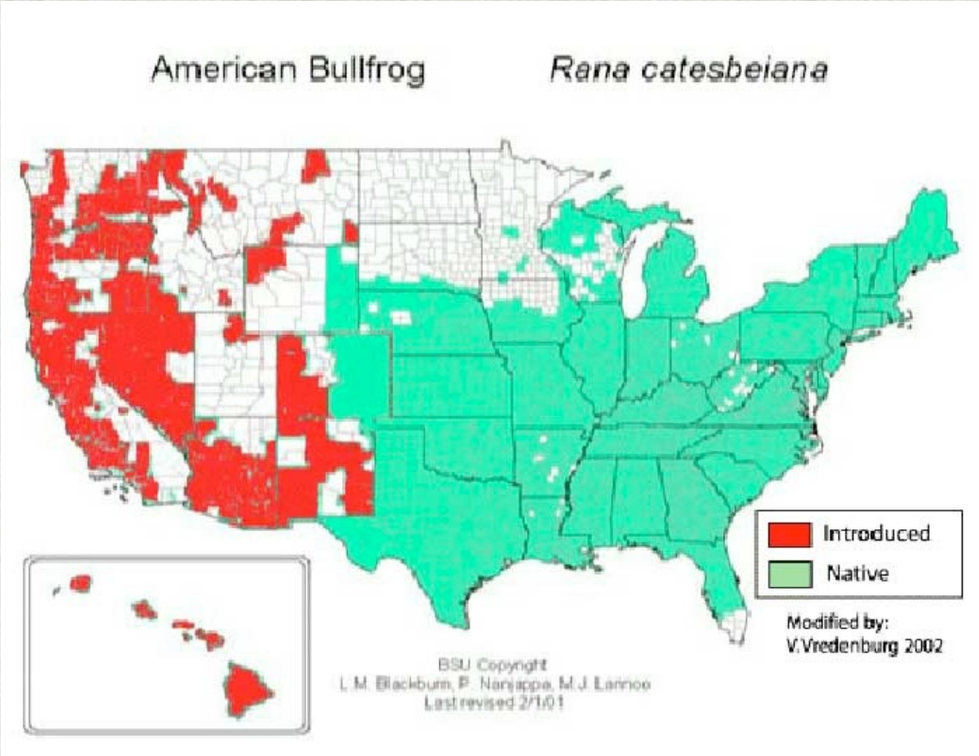
- Several examples of introduced fish affecting native frog species
- Example: Sierra Nevadas
- Most high-elevation ponds were fishless
- Since trout introduction, mountain yellow-legged frogs are very rare

RANA MUSCOSA,

VARIOUS TROUT

Introduced Frogs and Frogs

- American Bullfrogs are spreading through the western US
- Compete with and eat native frogs



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Over-exploitation

- People love frog legs
- Pet trade is huge, especially for things like poison dart frogs
- Many frogs used for dissection in sciences classes are wild-caught

Possible Causes

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- UV-B Radiation
- Chemical contaminants
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Amphibians breeding earlier

Species:	natterjack toad *Bufo calamita* © 2000 Arie van der Meijden	edible frog *Rana esculenta* © 2000 Arie van der Meijden	Palmate newt *Triturus helveticus* © 2002 John P. Clare
Where:	Hampshire, England	Sussex, England	Sussex, England
Reference:	(Beebee 1995)	(Beebee 1995)	(Beebee 1995)
Species:	smooth newt *T. vulgaris* © PENSOFT Publishers	great-crested newt *T. cristatus* © PENSOFT Publishers	grey treefrog *Hyla versicolor* © 1998 Joyce Gross
Where:	Sussex, England	Sussex, England	Ithaca, New York, USA
Reference:	(Beebee 1995)	(Beebee 1995)	(Gibbs and Breisch 2001)
Species:	spring peeper *Pseudacris crucifer* © 2001 John White	American bullfrog *R. catesbeiana* © 2002 William Flaxington	wood frog *R. sylvatica* © 2003 John White
Where:	Ithaca, New York, USA	Ithaca, New York, USA	Ithaca, New York, USA
Reference:	(Gibbs and Breisch 2001)	(Gibbs and Breisch 2001)	(Gibbs and Breisch 2001)

Amphibians not breeding earlier

Species:	common toad *Bufo bufo* © 2000 Arie van der Meijden	common frog *Rana temporaria* © 2003 Twan Leenders	American toad *B. americanus* © 2003 Brad Moon
Where:	Purbeck Hills in south Dorest, England	Sussex, England	Ithaca, New York, USA
Reference:	(Reading 1998)	(Beebee 1995)	(Gibbs and Breisch 2001)
Species:	western toad *B. boreas* © 2000 Joyce Gross	Fowler's toad *B. fowleri* © 1979 Alan Resetar	spring peeper *Pseudacris crucifer* © 2001 John White
Where:	Lost Lake, Three Creeks and Todd Lake, Oregon, USA	Long Point, Ontario, Canada	Germfask, Michigan, USA
Reference:	(Blaustein et al. 2001)	(Blaustein et al. 2001)	(Blaustein et al. 2001)
Species:	Cascades frog *R. cascadae* © 1998 Harry Greene	green frog *R. clamitans* © 2003 John White	
Where:	Site One and Todd Lake, Oregon, USA	Ithaca, New York, USA	
Reference:	(Blaustein et al. 2001)	(Gibbs and Breisch 2001)	

HTTP://AMPHIBIAWEB.ORG/DECLINES/CLIMATECHANGE.HTML

Possible Causes

- Habitat destruction
- Introduced species
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- Climate change
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- Chemical contaminants
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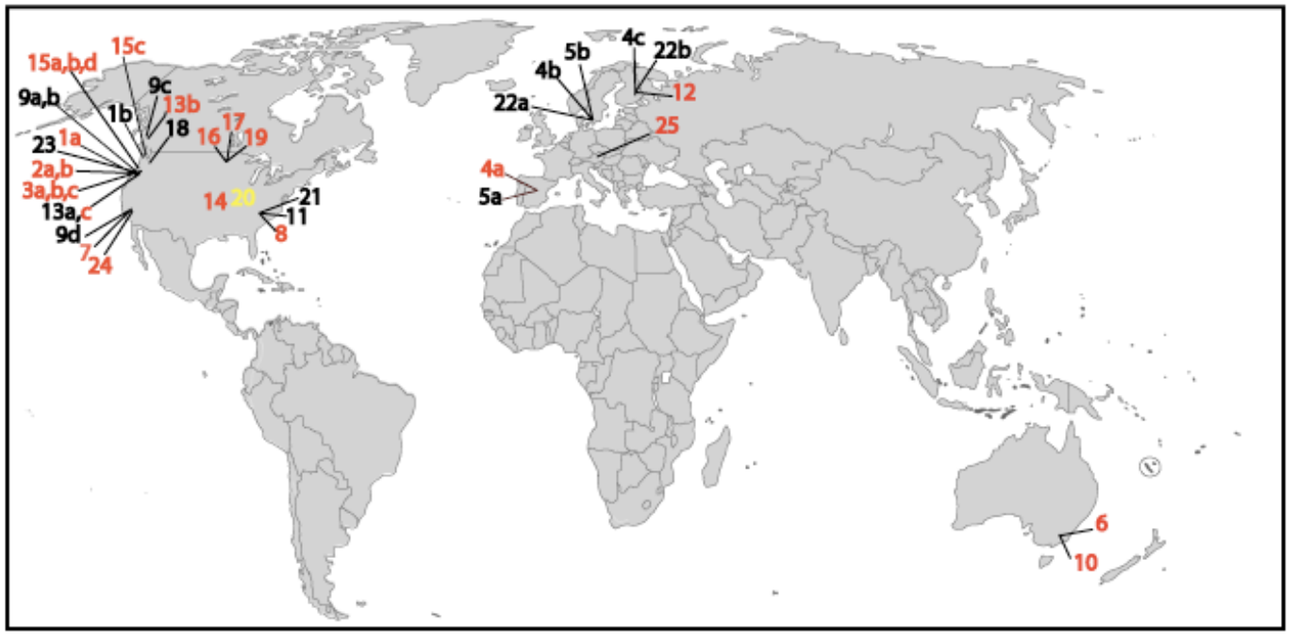

Figure 1. Areas around the world where UV-B field studies have been conducted. Each number represents a species and each letter corresponds to a study. Red letters represent studies that found a negative effect of UV-B radiation, black numbers represent studies that found no effect and the one yellow number represents a positive effect. For more information on each study see the map key (map and key prepared by Rebecca Doubledee 2004).

Table 1. Examples of studies showing lethal and sublethal effects of ultraviolet radiation alone or in synergism with other factors. Table modified from Blaustein et al. 2003.

© 2000 Joyce Gross	**Species:** Western Toad (*Bufo boreas*) **Effects of UV-B:** Exposure to UV-B increases embryo mortality, causes developmental abnormalities and hampers antipredator behavior **Synergism:** Exposure to high levels of UV-B increases susceptibility of embryos to infection by a parasitic fungus *Saprolignia ferix* **References:** Worrest and Kimeldorf (1976); Blaustein et al. (1994); Kats et al. (2000); Kiesecker and Blaustein (1995); Kiesecker et al. (2001)
© PENSOFT Publishers	**Species:** Great Crested Newt (*Triturus cristatus*) **Effects of UV-B:** Exposure to UV-B causes skin damage and erratic swimming behavior **References:** Langhelle et al. (1999)

Possible Causes

- Habitat destruction
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Pollution with known effects

- Pesticides, many have lethal effects on amphibians
- Example: Atrazine leads to hermaphrodites
- Heavy metals
- Acidification
- Nitrogen pollution

Contaminant	Species	Effect	Reference
Atrazine	*Xenopus laevis*	Disrupts steroidogenesis resulting in demasculanization and hermaphroditism	Hayes et al. 2002
Atrazine	*Rana pipiens*	Disrupts steroidogenesis resulting in demasculanization and hermaphroditism	Hayes et al. 2003
Chlorinated hydrocarbons	*Necturus maculosus*	Changes in secretion of corticosterone, which could hinder reproductive performance	Gendron et al 1997
Endosulfan (a cyclodiene organochlorine insecticide)	*Notopthalamus viridescencs*	Altered morphology of pheromonal glands in females and interfered with hormonal signaliing and mating success	Parker et al. 2001
carybaryl	*Hyla versicolor*	killed 60-98% of tadpoles when predatory cues were also present	Reylea and Mills 2001

HTTP://AMPHIBIAWEB.ORG/DECLINES/CHEMCON.HTML

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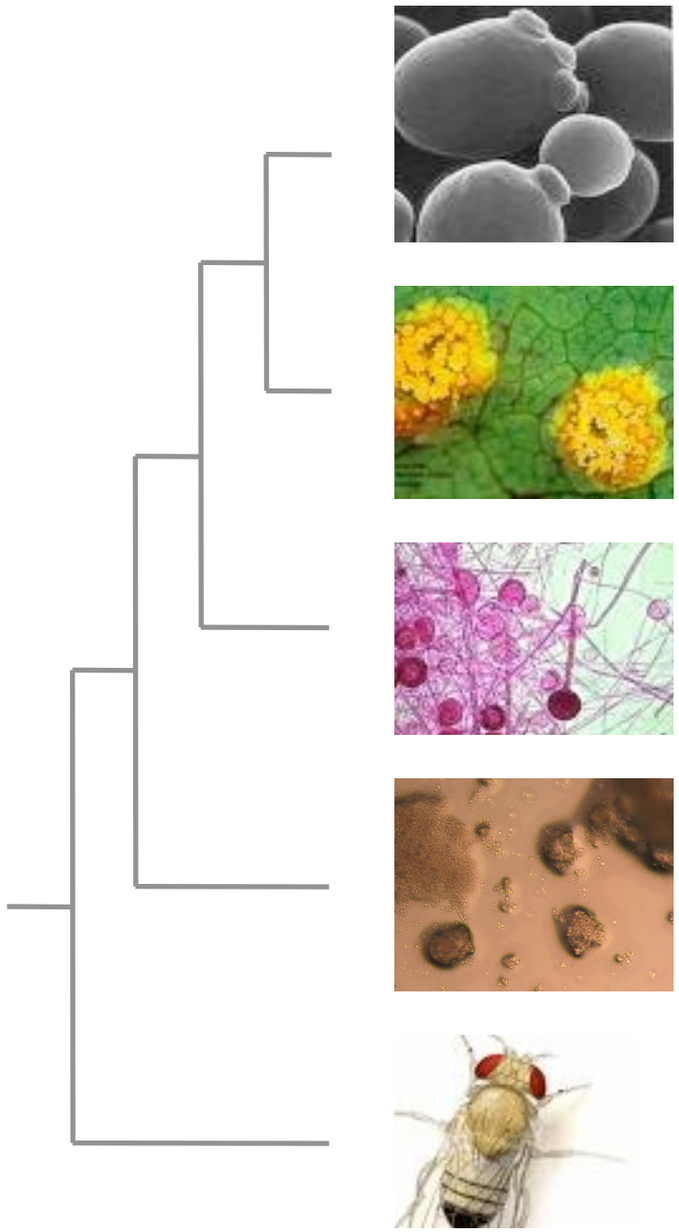
Chytrid phylogenetic context



Ascomycota

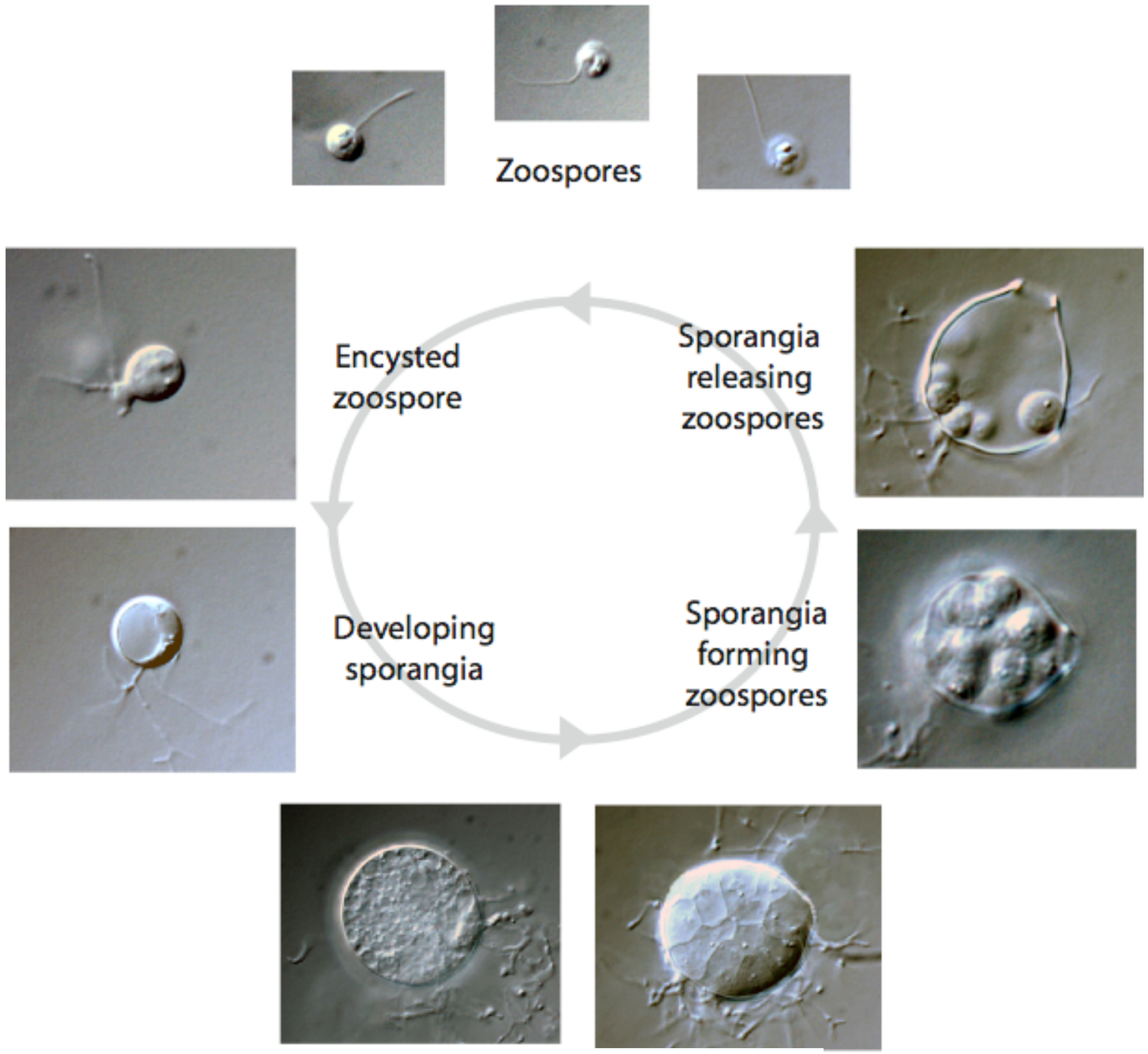
Basidiomycota

Zygomycota

Chytridiomycota

Metazoa

Chytrid life cycle

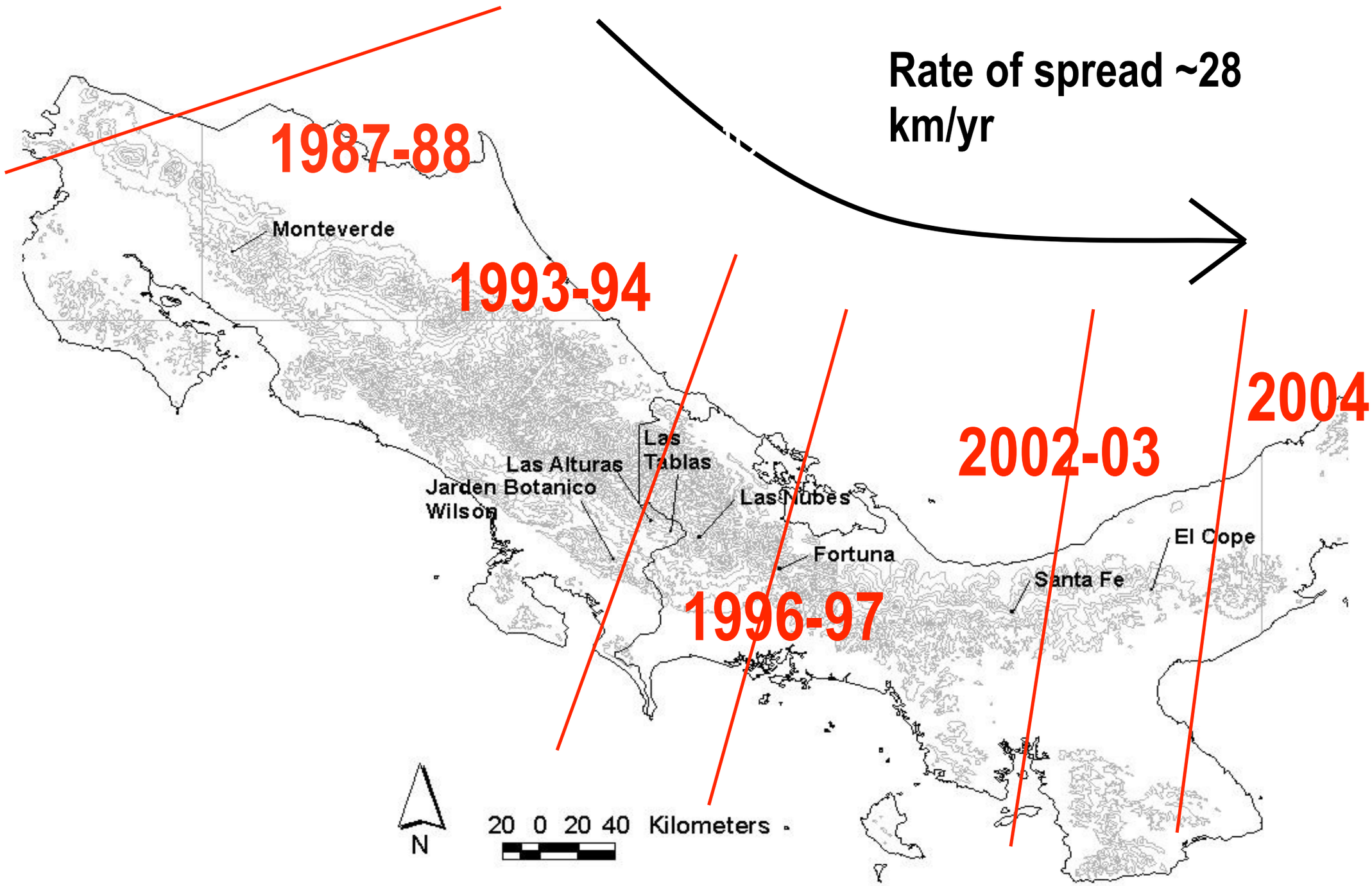


Global *B.d.* distribution

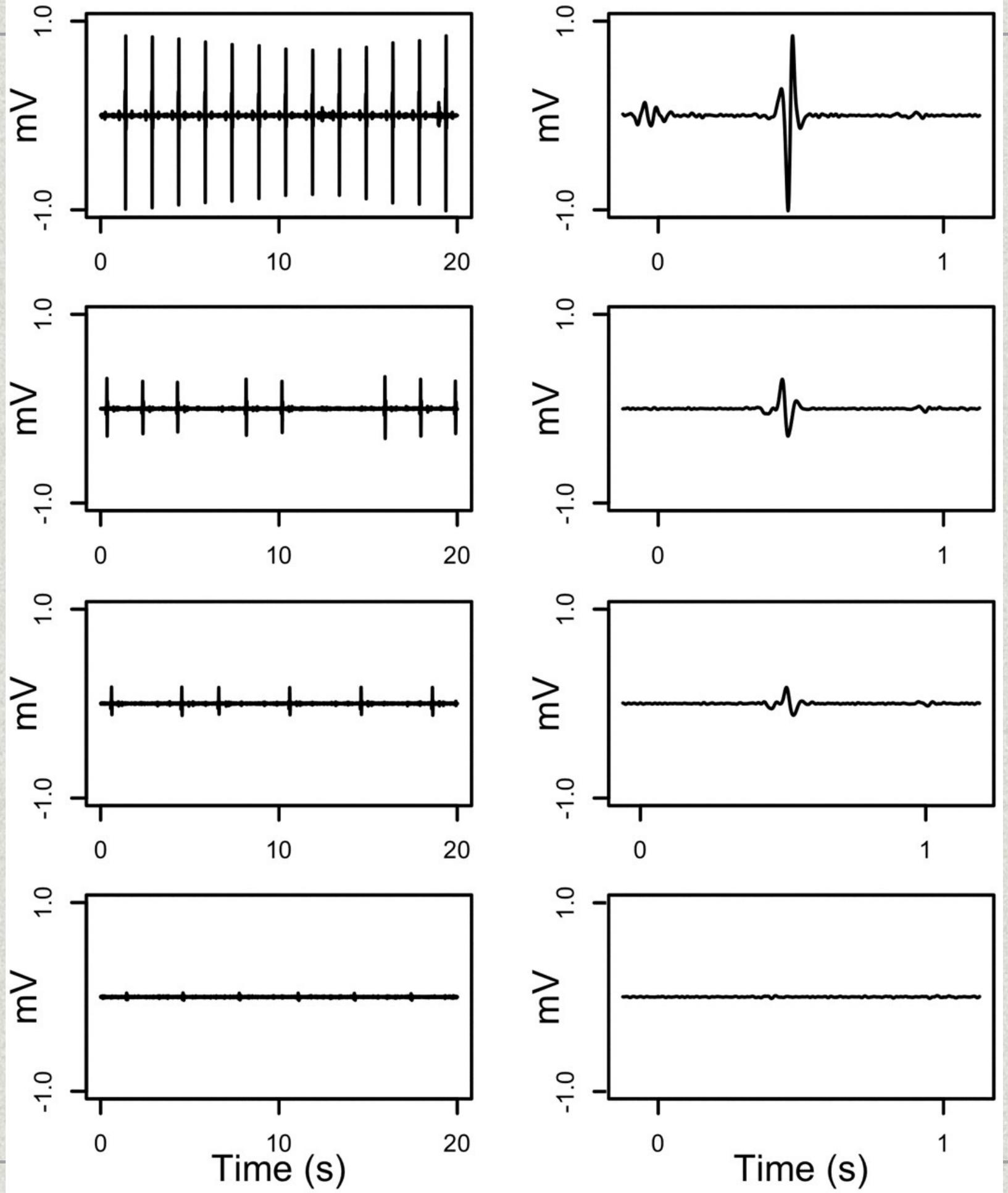
Map Source: Rachowicz et al. 2005

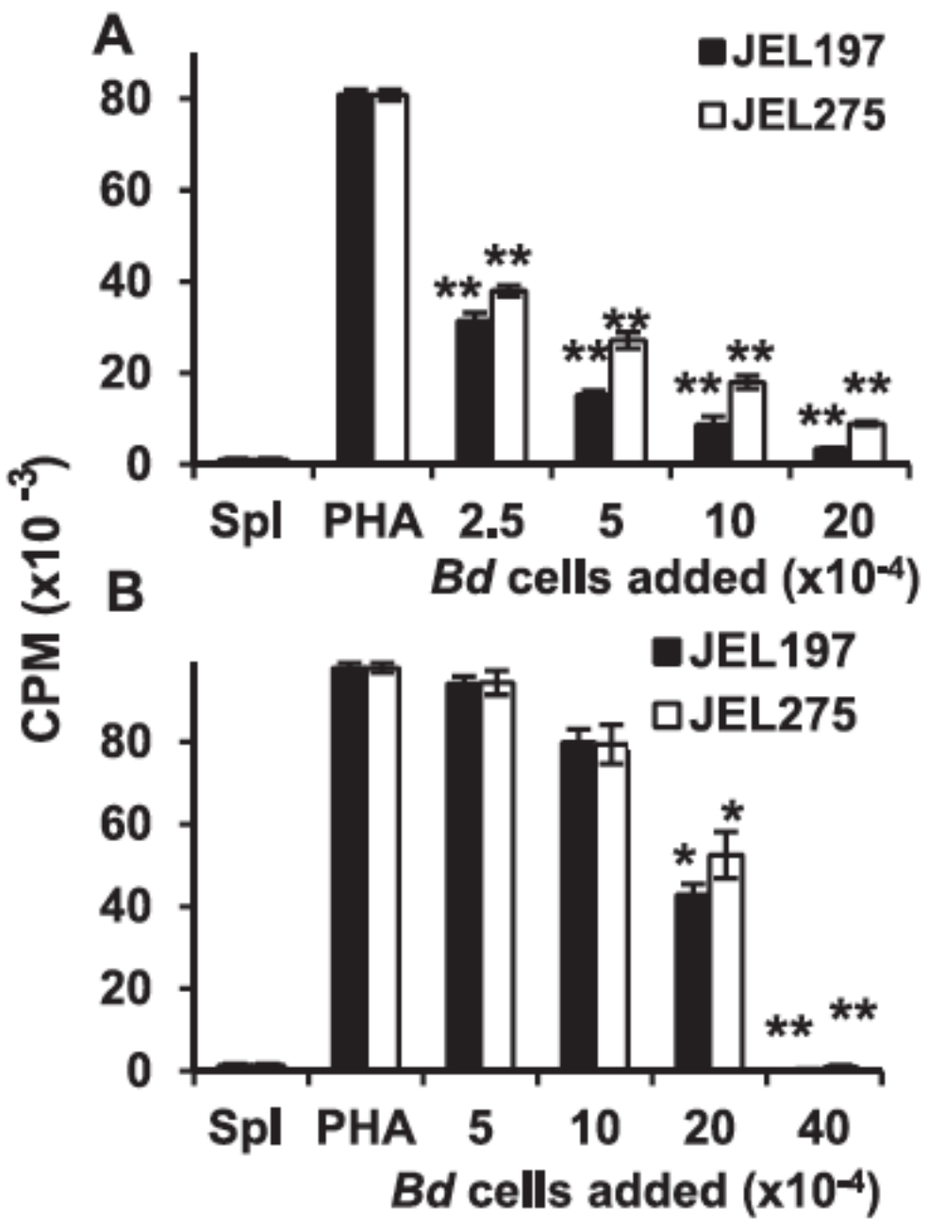
Photos by: H. Claessen, N. Litjens, R. Pushendorf, C. Colvin

Spread of Chytrid



Source: Lips et al. 2006, PNAS.


mV
1.0
-1.0
0
10
20
1
Time (s)


A
JEL197
JEL275
80
60
40
20
0
Spl
PHA
2.5
5
10
20
Bd cells added (x10-4)
CPM (x10-3)
B
JEL197
JEL275
80
60
40
20
0
Spl
PHA
5
10
20
40
Bd cells added (x10-4)

Possible Causes

- Habitat destruction
- Introduced species
- Over-exploitation
- Climate change
- UV-B Radiation
- Chemical contaminants
- Disease
- Deformities
- Synergies

Deformities

- Originally identified by a middle-school class in Le Sueur, MN
- Other reports from all over the world at the same time
- Parasites? Pollution?
- Difficult to identify causes in individual cases

Figure 1. (Right) Northern leopard frog (*Rana pipiens*) with dual bony triangles in the tibiofibula of the right hindlimb. Note also the mirror image duplication of the right foot (©Pieter Johnson). (Left) *R. pipiens* with two extra hind limbs extending ventrally from pelvic girdle (©Pieter Johnson).

Possible Causes

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Synergies

- Example: Climate change, UV, and disease in the western toad (*Bufo boreas*)
- Infection more common in drought years

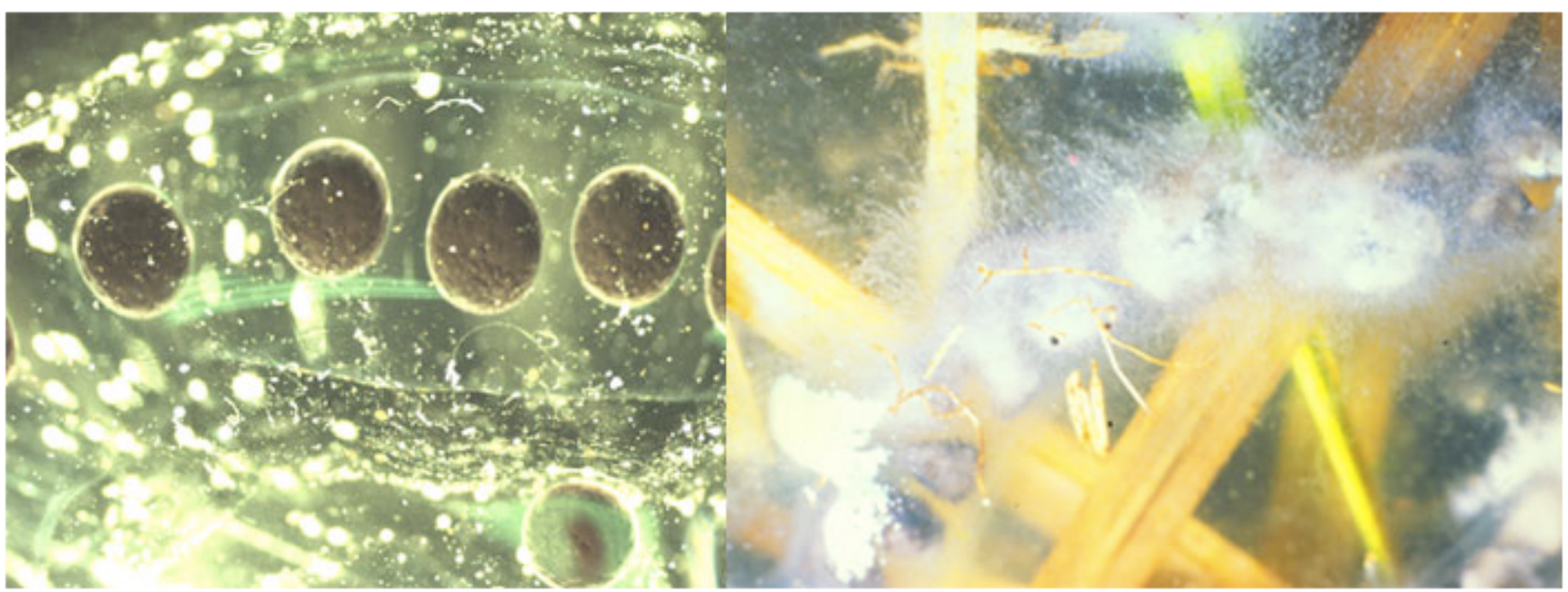

Figure 1. *Bufo boreas* eggs unifected (left) and infected with *Saprolignia ferix* (right). Photos by Joseph Kiesecker

Synergies

- Pesticides and disease in leopard frogs (*Rana pipiens*)
- Pesticides make frogs more susceptible to disease

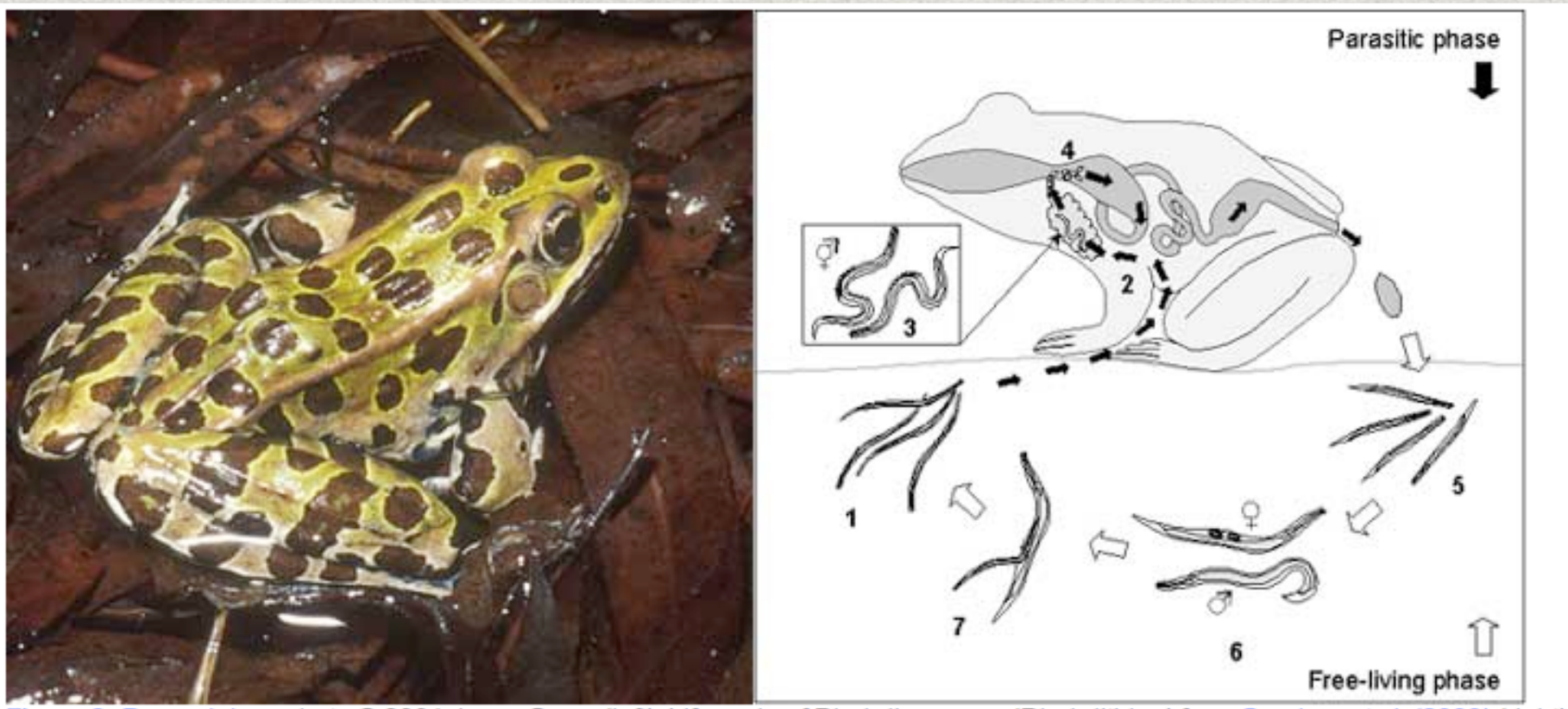

Figure 2. *Rana pipiens* photo © 2001 Joyce Gross (left). Life cycle of Rhabdias ranae (Rhabditidae) from Gendron et al. (2003) (right).

Possible Causes

- Habitat destruction
- Introduced species
- Over-exploitation
- Climate change
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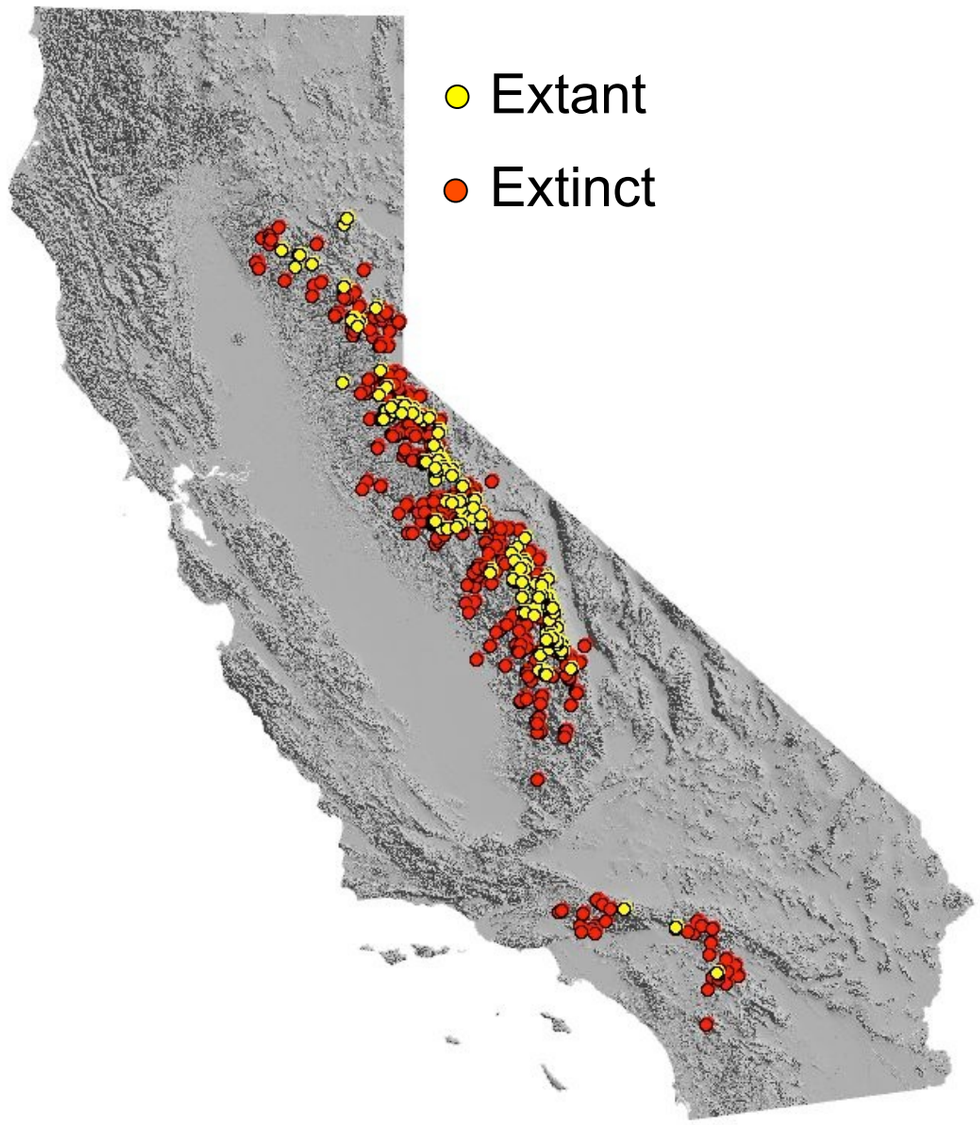
What can we conclude from this?

- Amphibian declines were initially greeted with skepticism
- “populations naturally change”, “we need more data”, etc.
- They are real, but there is no single cause
- Synergy among factors is important

Amphibian declines

- Identify and describe the problem
- Test possible causes
- Investigate potential solutions

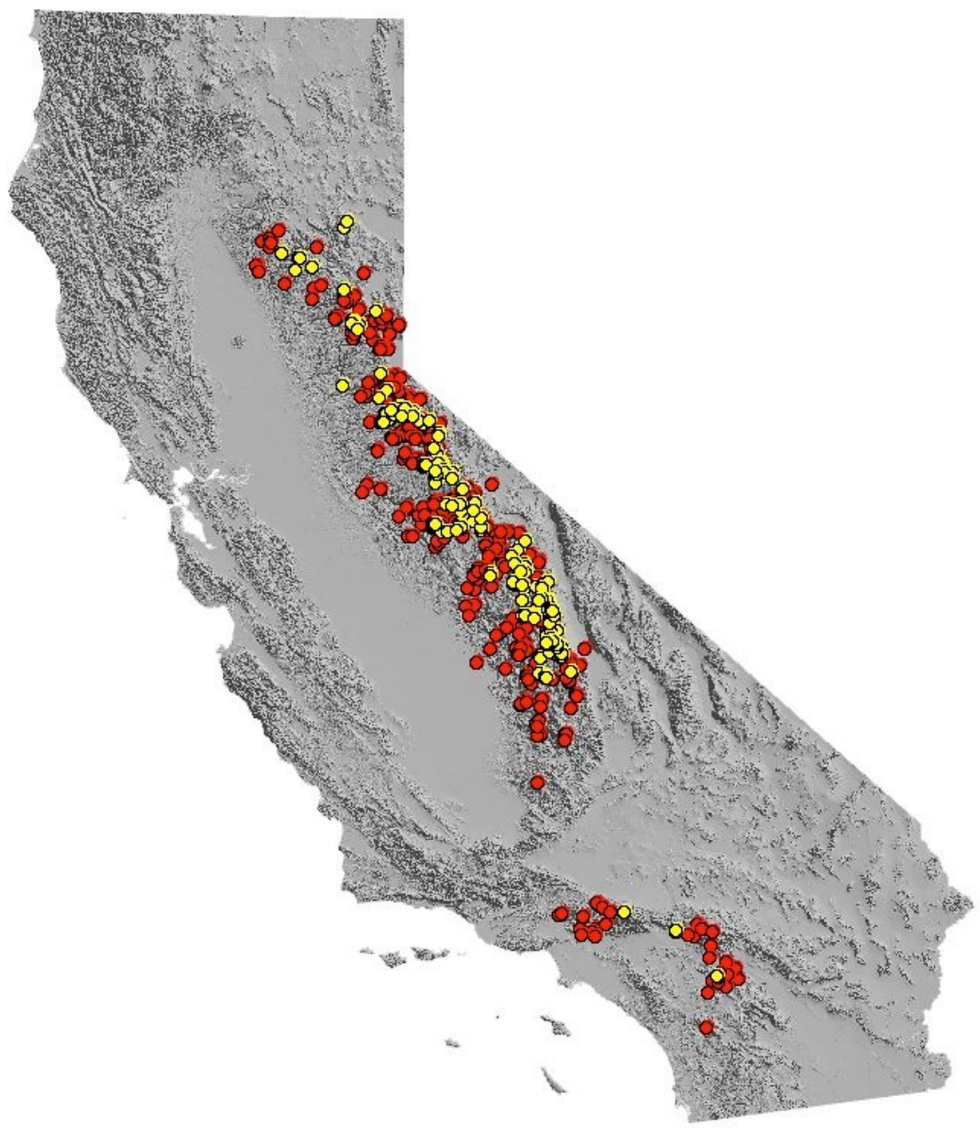
Different responses to chytrid among populations



Vredenburg et al 2007

Data: V. Vredenburg, Knapp, Briggs et al., MVZ, CAS, CDFG, USFS, USGS surveys, C. Davidson

Different responses to chytrid among populations



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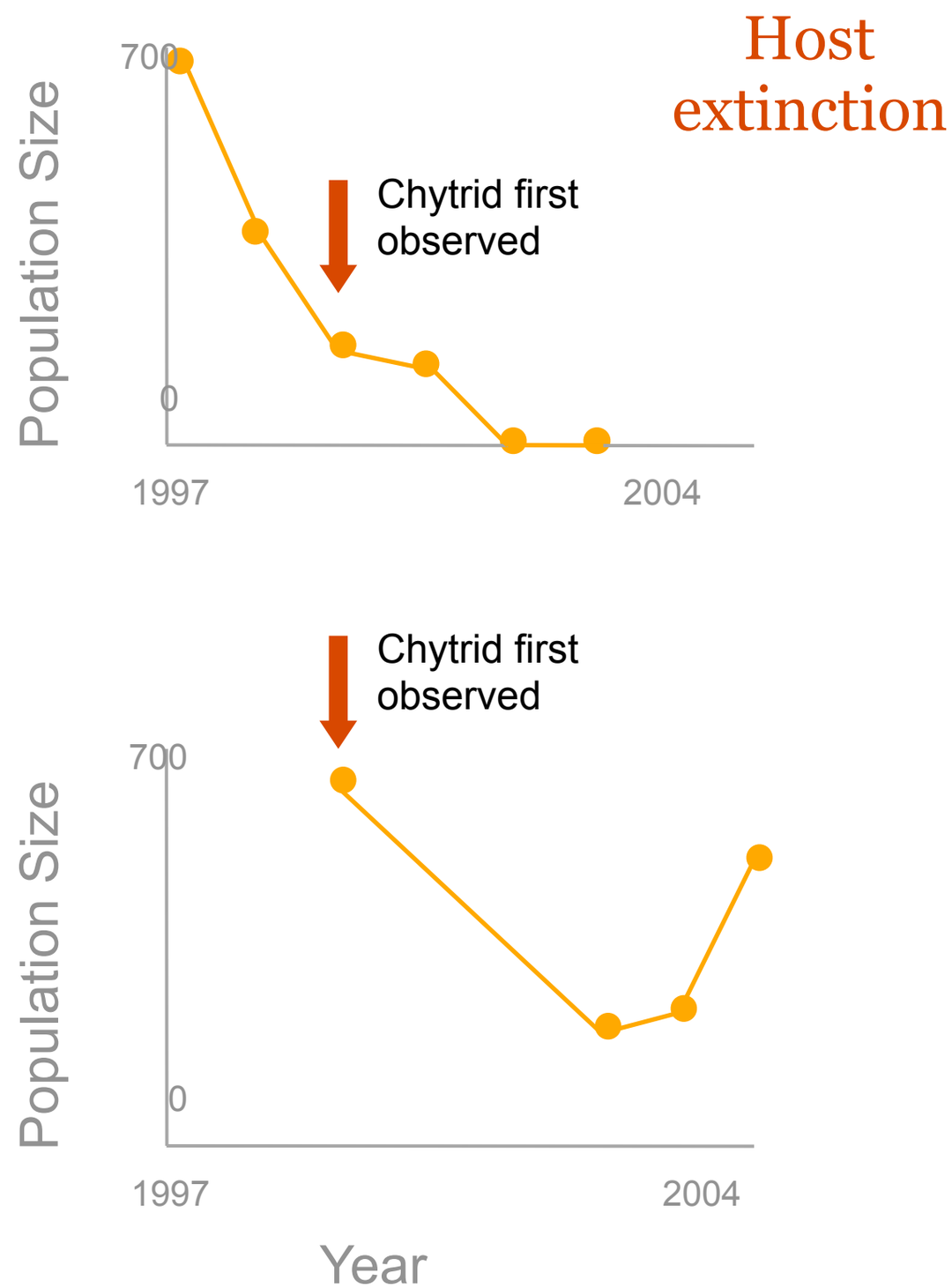

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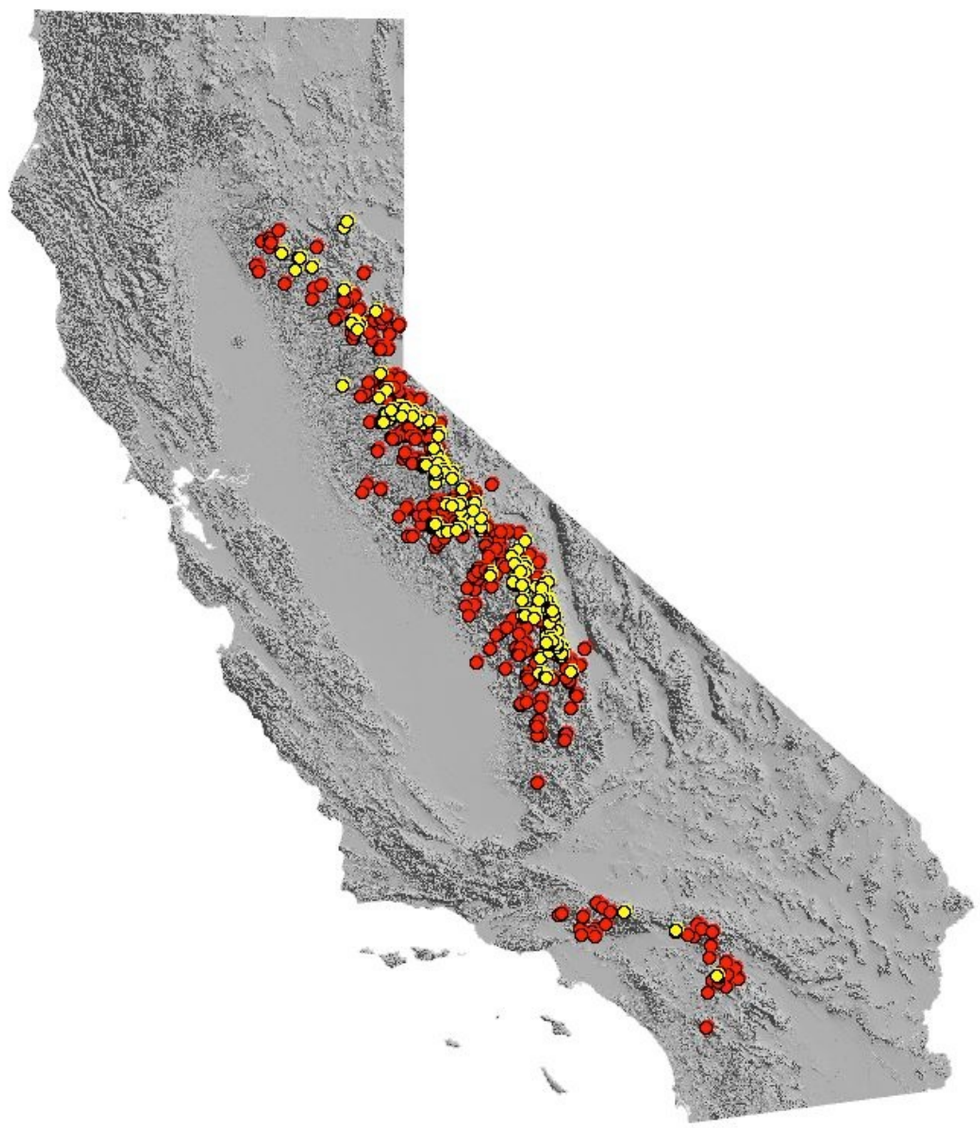

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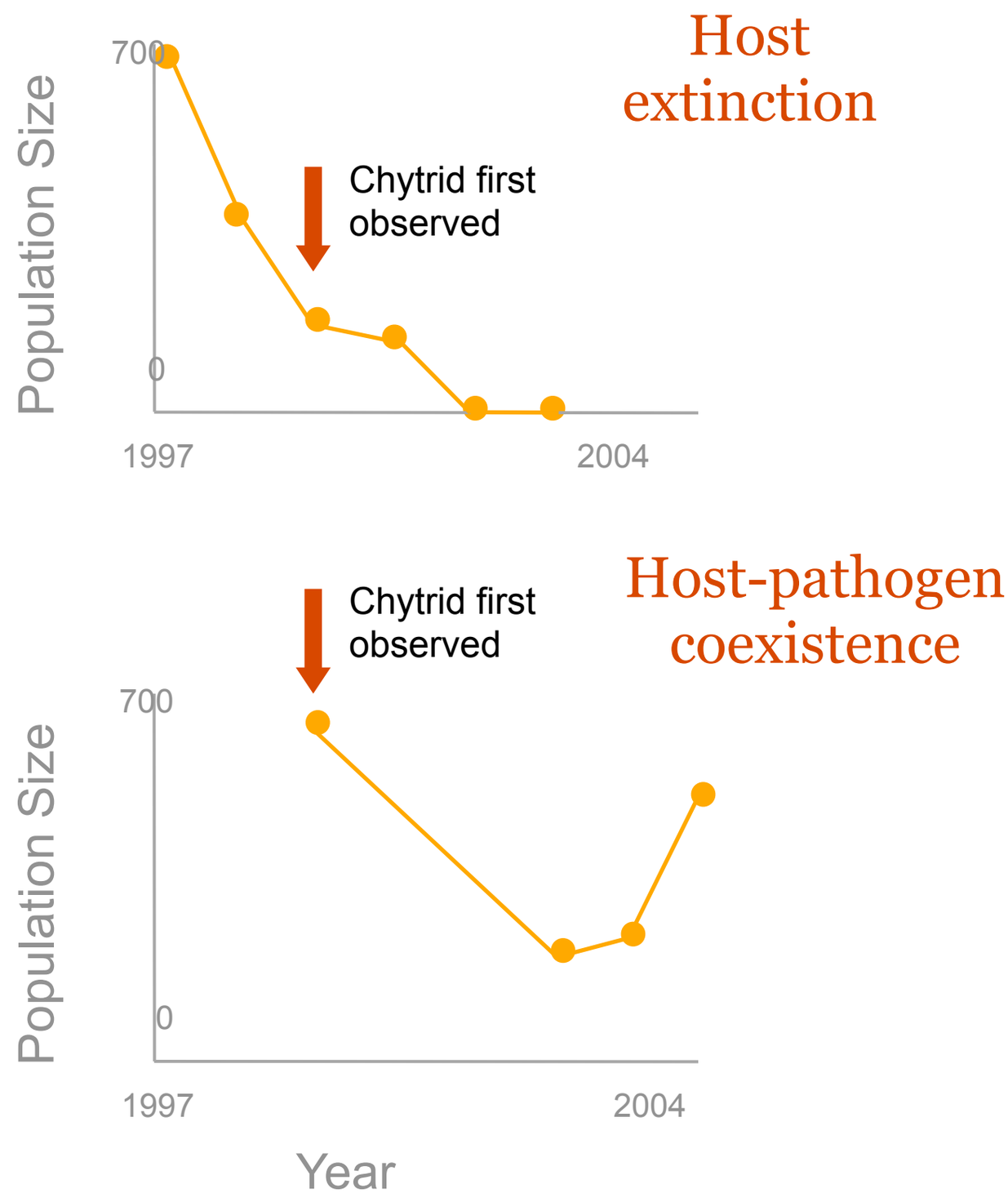
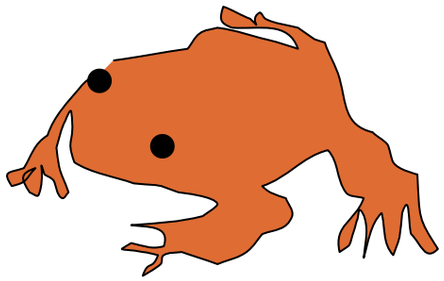
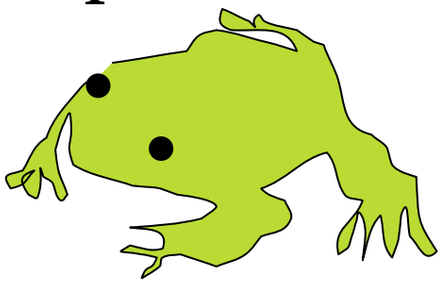


Different responses to chytrid among populations

declining



persistent



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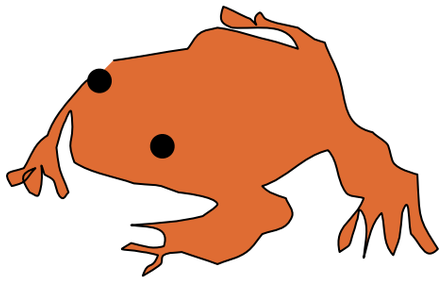

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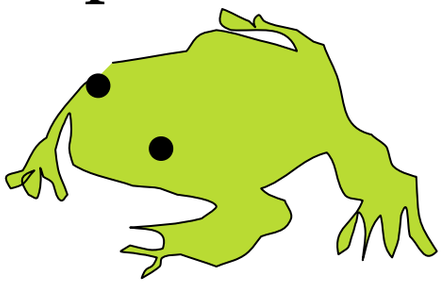
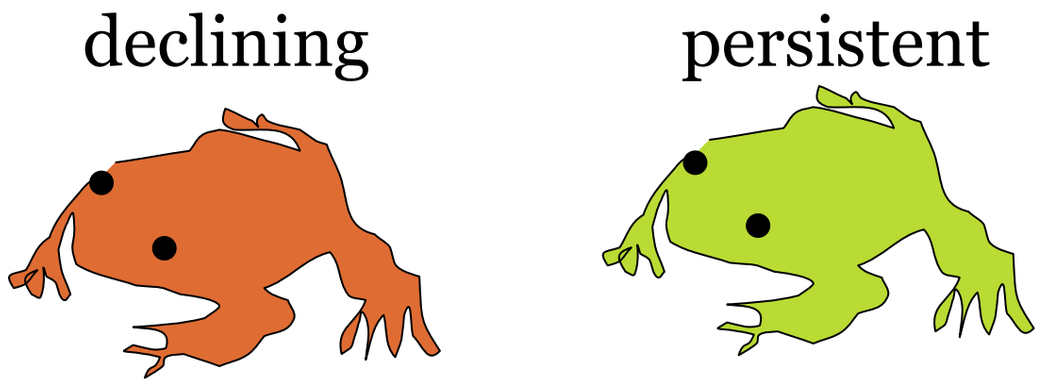


Could be due to differential:

- chytrid virulence
- frog susceptibility
- environmental conditions
- demographic factors

Different responses to chytrid among populations



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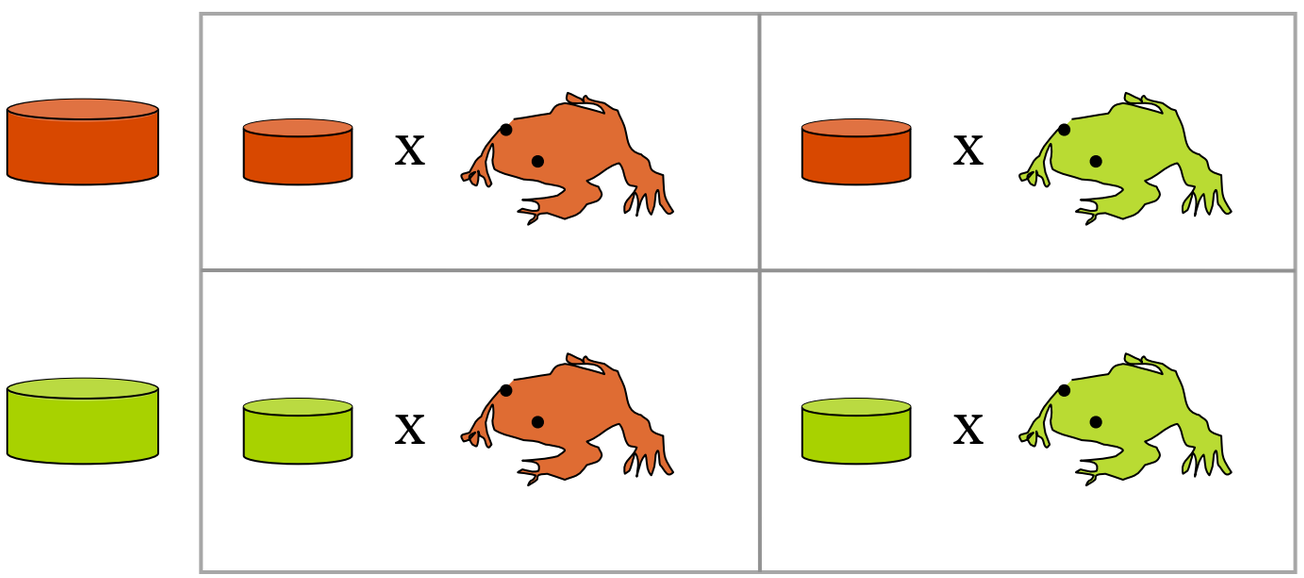

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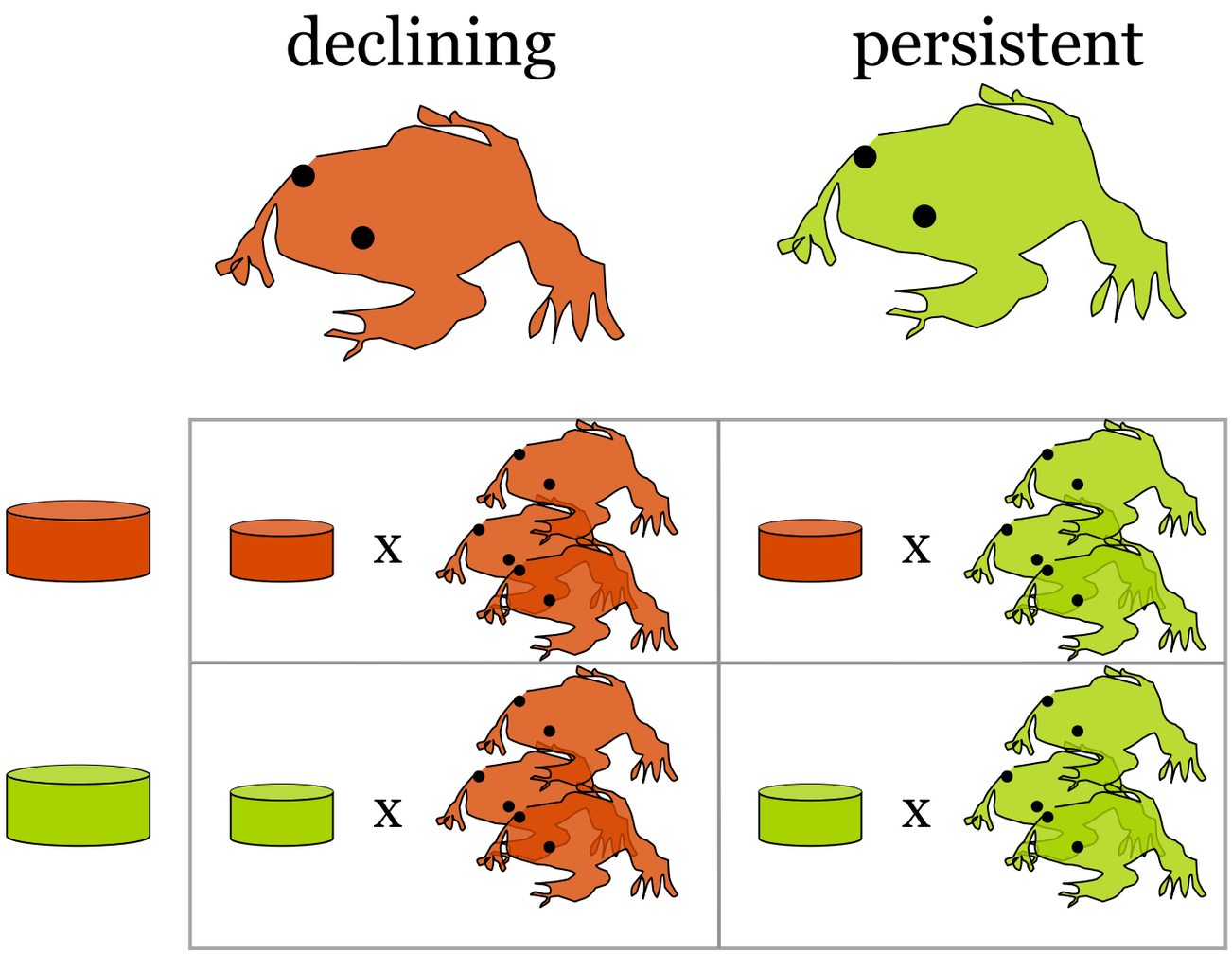

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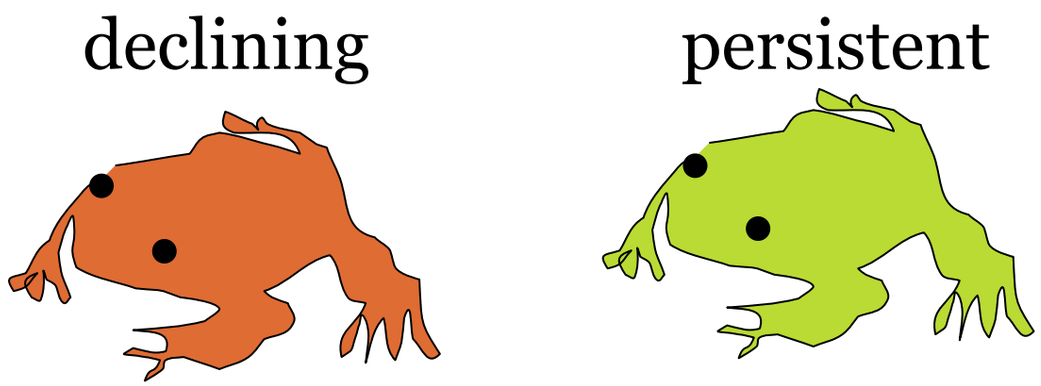

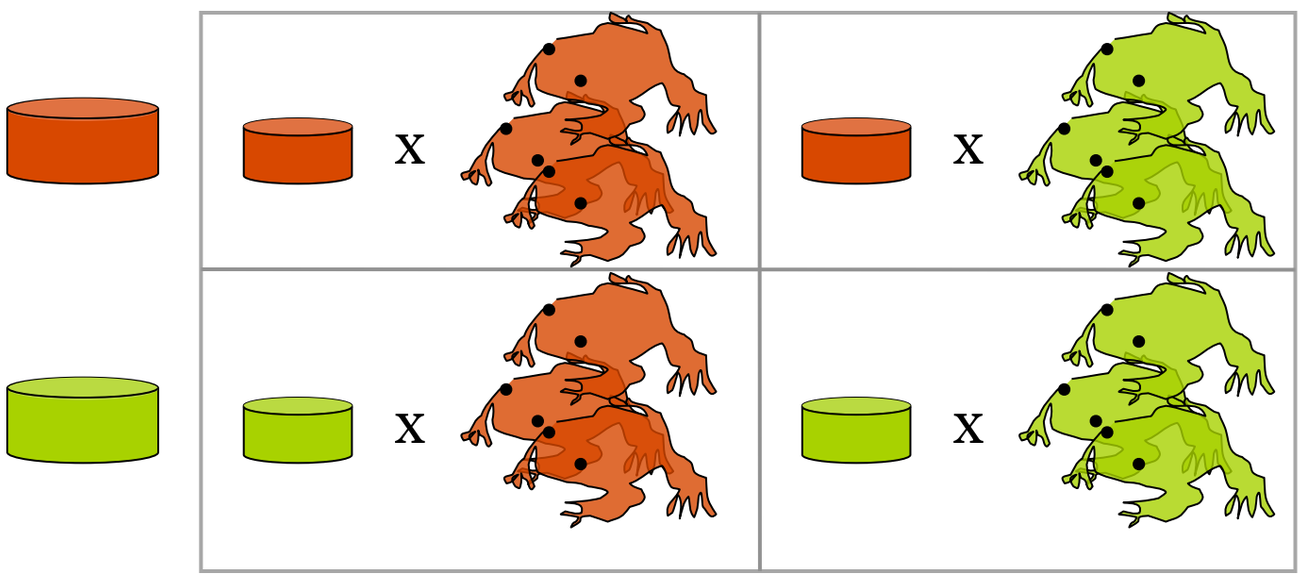

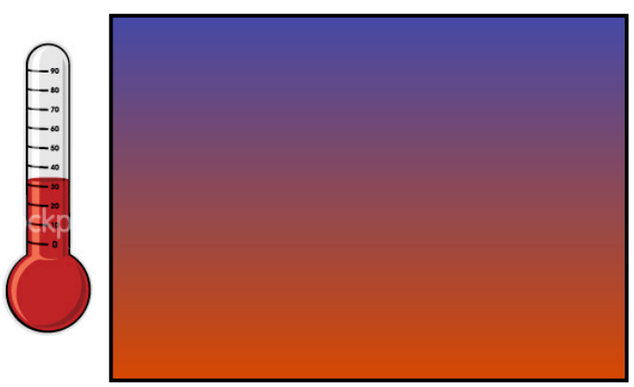

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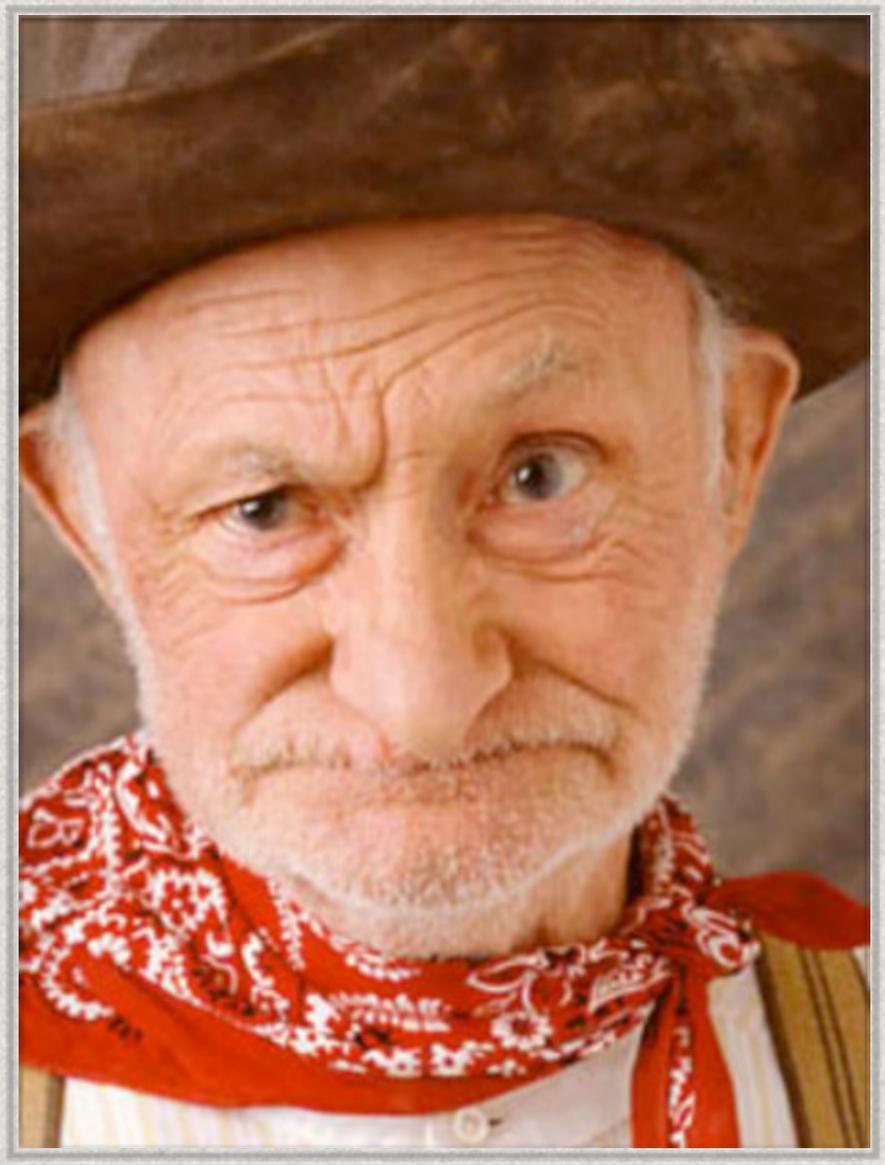
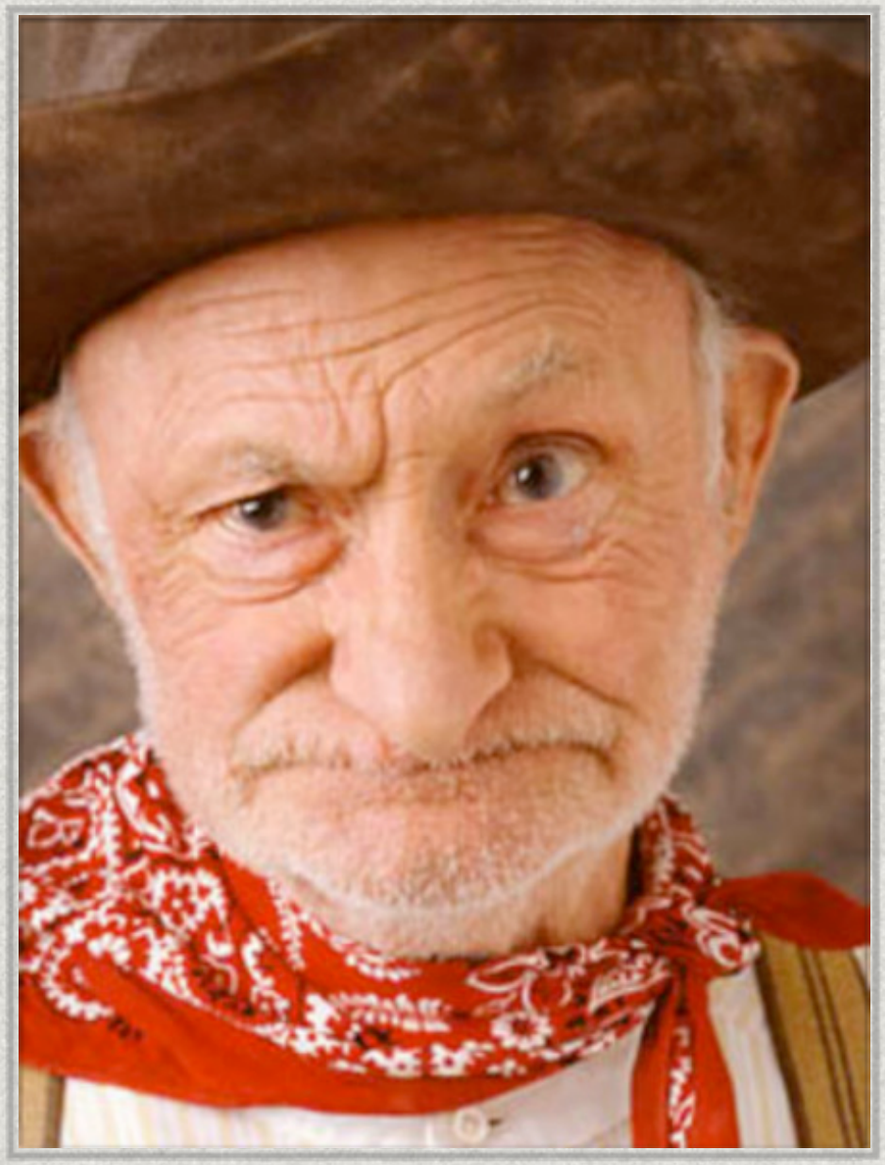
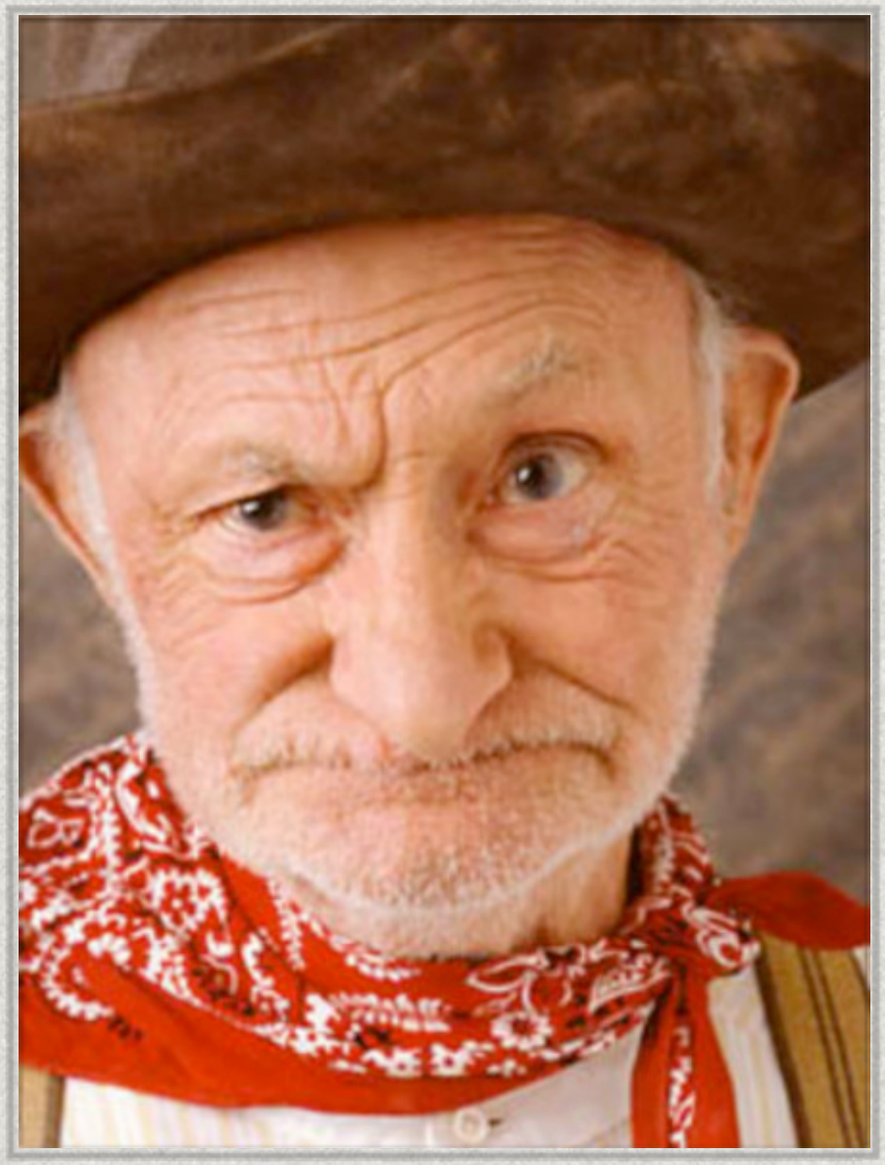
Activity



Activity

- “They live in the water. They eat grass. What more do you need to know?”



Activity

- “They live in the water. They eat grass. What more do you need to know?”
- On a sheet of paper, list and rank your personal **top three** reasons for conserving reptiles and amphibians